

1508/405

TREATISE
OF THE
PARTS
OF A
Humane BODY.
WITH
Their Respective USES;

IN WHICH

Their particular *FUNCTIONS* are clearly and fully Explain'd.

Deduced from practical Observations, and the late Discoveries of the Modern, and most Accurate Anatomists.

ALSO

A curious Account of the Organs of *Sensation*, Explaining their Faculties.

By John Baptist Verduc, *Doctor in Physick*,
Now made English by J. Davis, M. D.

L O N D O N :

Printed for William Turner, at the Angel at *Lincolns-Inn-back-Gate*. 1704.

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*A Treatise of the Parts of a
Human Body ;*

Dignum Censemus qui Impri-
matur, Jan. 29. 1703.

Edvardus Brown, Præses.

Gualt. Charleton, Elector & Cens.
Carolus Goodall,
Johannes Bateman, } Censores.
Johannes Woodward,



To the Reader.

to know the Nature of Diseases, unless a
Man know Nature: For how shall any
Man know what is against Nature, un-
less he knoweth what Nature is. Ad
causam ipsam et causæ occasionem
et primordia deveniendum est. For
want of which Necessary and just Qua-
lifications, it is too visibly, and too
sadly evident to the World; what Dis-
mal and Fatal Blunders are daily and
hourly Committed by the Modern Usur-
pers, on the Noble Science of Physick &
Qui parum docti satis seduli, mul-
tos ægros officiosissime occidunt.
Now, to prevent the ill consequences that
will always inevitably attend such blind,
rash and unwarrantable Practices, I
humbly conceive nothing can be more grate-
full to the Publick, or at least to the
more Candid and Sensible part of Man-
kind, than such kind of Discourses or
Treatises,

Hippoc. r.
Virginum
Morbis.

Hippo-
crat. Lib. 2.
Epid. Sect. 4.

To the Reader.

Treatises, which both agreeably and insensibly lead us into the Mysteries of Nature.

It is on such considerations as these alone and the desire of being serviceable to the Publick, that I have ventured to Recommend to thy Perusal, the following Treatise of the Ingenious Author, whereof it is convenient I should say something here. Let this be sufficient then to inform thee, that of all the many Treatises he hath Publish'd, this is the most Elaborate, being in the Judgment of several Learned and Ingenious Physitians and Philosophers, the most compleat Work now Extant on this Subject, and accordingly it met with an Universal Approbation Abroad.

The Author stood in great Reputation at Paris, and dy'd in the Flower of his Age, equally Admired and Regretted

TO THE

Honourable, My Lord,

THOMAS PETRE,

Baron of *Writtle*.

My Lord,

THE Homage and Adoration,
which Antiquity (forgetting
the First and Supreme Cause
of all Beings) paid to those (their
imaginary Deities) the glorious and
Celestial Luminaries the Planets, was

The Dedication.

not, as I humbly conceive, so much on account of their dazeling Lustre, and that bright glittering shew, which they made above all other Creatures, but more particularly on account of their Powerful and Beneficial Influences, which they were always shedding and scattering on the Barren World below. From the like Cause or Fountain, viz. of having happily been the Authors of some Publick Benefit, or having happily rendred some eminent and signal Service to their Native Prince or Country, hath sprung the Illustrious Race of Heroes, and that just and necessary distinction of Nobility among Mankind, which have rais'd, and even supported so many Noble Families, above the common Mass and Level of Mankind: *Sola atque unica Virtus Nobilitas.* From hence arose (as our Annals do inform



The Dedication.

inform us) amongst that of many others, the Glory and Splendor of Your Lordships Most Honourable Family,

But pardon me, My Lord, I do not here presume to amuse you with a Panegyrick; its well known Your Honour is as much above it, as I am unqualified to write it: I am really too Conscious, of my own poor Talent, to fondly imagine, that any Performances of Mine, can be judg'd worthy of being presented to Your Lordship,

It is then, my Lord, to deal ingenuously, partly for shelter, that I bring this Stranger (of great Merit and Reputation in his own Country, tho' now in an *English* Dress) to Crave Your Lordships Countenance

The Dedication.

and Protection ; and partly to leave the World some small short Essay, as a lasting Testimony of my Gratitude, for the frequent Favours I have receiv'd of Your Lordships Generosity and Bounty.

But what shall I say? To Shelter and Protect the Muses, to Build them Temples, to Encourage even the poor Pretenders to Learning and Sciences, hath been a long time Hereditary, and, in a manner entail'd on Your Lordship's honourable Family, Witness those two Renown'd Societies or Colleges of *Exeter* and *Wadban*, in our famous University of *Oxford*, who, in a great degree, owe their very Being and Prosperity, to the Generosity and Liberality of Your Lordships glorious Ancestors and Predecessors, from
which

The Dedication.

which foresaid Seminaries have sprung, even in this our Age, many who have prov'd great Ornaments to their Country, Men Renown'd for their Learning and Piety, who by their more Accomplish'd Qualifications, as I humbly Conceive, may abundantly supply the defects of my poor Pen, or this noble Subject. *Inopem me Copia Facit.*

Since Custom then, my Lord, in this case, will in some degree Apologise for this my present boldness, I hope, your Lordship will be pleas'd heartily to forgive, and graciously to accept, what I here humbly and sincerely offer at Your Lordships Feet, *Ego Farre litabo.*

This will encourage me to find out something, for the future, that
may

The Dedication.

may, perhaps, be thought more agreeable, or more worthy of Your Lordship's Acceptance. Thus wishing Your Lordship many happy Years, and humbly praying that Immense Fountain of all Goodness, to Crown Your Honourable Family with Health and Happiness.

I humbly Presume to Subscribe
my Self,

My Lord,



Your Lordships most Obedient,

most Humble,

and Devoted Servant,

John Davis.

TO THE
READER.

TH^O there are some Bold and
Empirical Squires, who being
Conscious of their own Defects,
do openly and impudently maintain, in
these Times, that bold and dangerous
Paradox, viz. That it is not any ways
necessary to trouble One's self with know-
ing the cause of Diseases, provided a
Man hath a secret and safe Medicine
to Remedy, or to Cure it: Yet, I am
very apt to perswade my self, that there
is no Genuine Son of Apollo, or Æscu-
lapius, but will readily Subscribe to this
Pro-

To the Reader.

Proposition, viz. That there can be no solid, honest or rational Way of Practising Physick, without being first well Vers'd in a true Theory of Diseases, and consequently being well acquainted with Nature herself in all her Functions and Operations. For tho' a Modern Author (who looks on all Hypotheses as so many Romantick Dreams) doth plainly assert, that we are not able precisely to know, how any of our most common Functions are perform'd; yet we are not to rest satisfied with the most rational, or most satisfactory Hypotheses that are publish'd on this Subject, till we meet with better, and not to sit down with a despair of knowing any thing, but still pursue the Discovery of Nature.

For as the Divine Oracle of Coos bath of old asserted it, it is impossible

To the Reader.

d. By what he hath left behind him
e may well judge how great a Trea-
re Death Rob'd the World of, by
atching him away so untimely, in the
idst of his closer pursuits of the Se-
rets of Nature. But for thy further
Satisfaction, I refer thee to the following
Approbations, and thy own impartial pe-
usal.

The

To the Reader.

*The Approbation of Monsieur
Bourdelot, Physician in Or-
dinary to the King, and to
Monseigneur the Chancellor
and Doctor of the Faculty
of Paris.*

I Have read, by vertue of an or-
der from the Chancellor, a Book
which is thus Entituled, *A Treatise
of the use of the Parts of Human Bo-
dy, with an Account of the Organes
of the Outward and Inward Senses*
Compos'd by Monsieur Verduc.
I found this piece to be so judi-
cious and accurate in the explaining of
the Functions of the Body, that
I thereupon judg'd it very fit to
be Printed, and Publish'd. This
sincere Testimony I give of it to
publick.

August the 9th.

1695.



BOURDELOT

*The Approbation of Monsieur
de Caen, Doctor of Physick,
of the Faculty of Paris.*

IF the former Works of the late
Monsieur *Verduc* have met with
so general an Approbation, we may
also presume, that this last piece,
which his Brother took care to pub-
lish, will be equally acceptable to
the Publick; and tho' the Subject
he Treats on hath been already hand-
led by some of the Moderns, who
only publish'd some Essays in Latin,
we may boldly assert, that the new
discoveries we meet with in this
piece, and the exact order into which
he hath digested them, will entirely
satisfy our Curiosity, as to the *Eco-*

nomy of Animals. Therefore his too sudden and unexpected Death, will make him lamented by all, who have been any ways sensible of his great Skill, or Judgment in the Mechanicks, his quick and piercing penetrating Faculties, his solid Judgment, and easy Genius, all which very well qualified him to write on any Subject of Physick or Anatomy. This is the Testimony which I sincerely give,

Paris,

Feb. 28. 1696.

De Caen.

*The Approbation of Monsieur
Vernage, Doctor of the same
Faculty of Paris;*

I Have read this Posthumous Work
of Monsieur *Verdus*, the perusal
of which will be highly advantagi-
ous to all such as apply themselves
to Anatomy ; it will bring them per-
fectly acquainted with the Senti-
ments of the Ancient and Modern
Writers, on the Functions of Hu-
man Body ; they are here related in
a plain short Stile, which will save
them the trouble of reading an abun-
dance of Books, for their better In-
struction. Our Author delivereth
his Judgment of the Opinions of
one and the other, very Learned-
ly. What Side soever he taketh,
is

is back'd with such solid Reasons, that one would take it for the best. Where the Authors have not altogether hit the Point, or seem to have fail'd, he hath supplied their Defects with such solid and ingenious Explications, and so Mechanical, that the Reader may thereby see, that he was not only capable of relating faithfully the Opinions of other Men, but that he was, in some Degree, himself an Author on these Subjects.



Paris,

March 16. 1696.

VERNAGE.

*The Approbation of Monsieur
Berger, Dean of the Faculty
of Physick in Paris.*

HAVING heard the Account or
Relation of Monsr. Caen, and
Monsr. Vernage, who were appointed by
the Faculty of *Paris*, to Examine a
certain Book which was writ by the
late Monsieur *Verduc*, Entituled, *A
Treatise of the Use of the Parts, with the
Organs of the Outward and Inward Senses,
&c.* The said Faculty giveth its free
consent for the Publishing of it.

Paris, March 17.

1696.

Sign'd,

BERGER, DEAN.

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TOME

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and Inward Senses are Accurately
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THE

T H E

Use of the PARTS

According to the

MODERNS.

CHAP. I.

Of Generation.

SO admirable, and so misterious is the Generation of Man, that even the *Sadduces* (of this Sceptical Age) who deny the Resurrection of this Body, and look on it, as a pure Impossibility; do manifestly thereby, discover their own want of Judgment and Understanding; for did they but hearken a while to the Dictates of common Reason, they would readily confess, that it is as easy for Nature to form a Humane Body out of any Matter whatsoever, as at first to form an Infant from the simple Union of the different Sexes. So great truly, and surprizing are the Wonders we meet with in the Generation of Animals, that they might easily convince us, that the Philosophers, neither said, nor thought, that the Soul of a Mare was the cause which organised, and animated a Colt (did not a world of Books assure us the contrary.) For how, I pray, is it agreeable, to common Sense, to pretend, that a Beast should be

B endued

endued with that Light, or with those Instructions, that are necessary towards the turning of a few drops of Blood into a certain Machine, whose Organs for the infinity of their number, their exact Symmetry and Use do ravish our Senses, and even transport us into an Extasy of Admiration? And if this were not enough to disabuse the most capricious, and most obstinate Atheists. Yet at least, out of a common Respect, and a just Deference, had to the Prerogatives of the Female Sex, let them not so much as once imagine or conceive, that even Brutes transcend them in their Capacity, or Understanding.

Every one knoweth, that Women are not the cause which organiseth, or fashioneth the Child in the Womb; and how, indeed, is it possible that they should Organise it, since they are altogether ignorant, where to begin, or where to leave off. Moreover, it is very well known, that some become Mothers in spite of themselves, and often in defiance of a Thousand Remedies, which some take, to prevent the blasting of their Reputation. On the other side, there are some again, who, notwithstanding their most vehement Wishes to the contrary, and in spite of all the Tricks and Councils imaginable, do yet continue barren. In fine, there is no one, tho' never so fruitful, but may humbly set down, and say with the Mother of the Maccabees; *That she is altogether ignorant how the Child is form'd in her Womb, and that it is not her who hath proportioned its Limbs.*

Since there is no Man in the World, (tho' never so wise or Learned) who knows what he must do, to make a Bone here, and Flesh there, in this place a Liver, and in another, the Intestines, or Gut, and so on. After all this, how is it possible to believe, (did not their Books inform us so) that many Philosophers and School men have asserted, and do daily assert, that Animals are the Efficient cause of the Organs and Life of their Young. Methinks from thence by the way, one may strongly infer, that Animals or Brutes, are only pure Machines.

For if it be true, as it cannot be denied, that the Body of Brutes is formed without any Knowledge on the Male or Female's Side, why may it not move, and feed itself after it is come into the World,



World, without any Direction or Influence from the Object? For if the most difficult Work may be done without Knowledge; it is evident, that what is less difficult, may also be perform'd without Knowledge.

Now it being evident to all, that it is incomparably more difficult to turn an Egg into a Dog, than it is to make the same Dog run after a Hare; we must conclude, that if Knowledge is not at all necessary for the changing of an Egg into a Dog, much less is it necessary for the same Dog, in order, to pursue a Hare.

They who believe the pre existence of Souls, do imagine, that they build their own Habitations, when once they shut themselves up into an Embryo. Others do in effect, advance the same Proposition, notwithstanding they teach; That the Soul is created in the very moment, in which it is united to the *Germen*, or *Embryo*; they will say, that the *Facultas Formatrix* immediately falls to Work on the Body, which is united and fitted for it.

But if the Souls had then this pretty kind of Knowledge, whence is it that they should altogether forget it? And why retain they not some Idea of it, during their Life? Methinks then, to explain this *Phænomena*, we must recur to the Laws of the Communication of Motions. But if those who have diligently applied themselves to the Study of these Laws of Mechanism, do not yet find them sufficient to explain the forming of so many Organ's; and that they make us to understand, that in this mysterious Work, certain Occasional Causes do intervene, which we are not acquainted with; perhaps they will say, that God at the Request of some Angel, determines to move the Materials of Living Bodies, after such a manner, as is necessary for one part to harden it self into Bone, and another to become Flesh: These are all without doubt, great Mysteries, not to be fathom'd, and we should be very happy without going any farther, could we but at least discover the Order, which the Author of Nature observeth, in producing this our own Machine.

In order to the Production of Animals, both Male and Female must each of them club their Share;

without which they continue barren, or unfruitful: Now the Seed of the Male is to be looked on, as the Efficient cause of this Production, and that of the Female, as the material Cause: For that which the Mother contributes towards the forming of the *Fetus*, is of a much different Nature from that which the Man furnisheth for the same end: The Seed which the Woman yieldeth here, is enclos'd in little Bags, or Bladders, commonly called Eggs, from the likeness they bear to the Yelks of Birds Eggs; and consequently, we may safely assert (without going any farther on this Subject) that all Animals at first proceed from an Egg.

As for that distinction, which hath hitherto been made betwixt Fowl, and other Animals, one may say, that after all the Experiments which the Moderns have tried on both Species, this distinction is in no wise well grounded: In short, if you nicely examine the forming of a Chick in an Egg, and that of a *Fetus*, in the *Matrix*, you will find that they are both perform'd after the same manner; yet still with this difference, that the Egg wherein the Chick is formed, doth more abound with a certain Liquor that is fit to nourish: it whereas the little Bags contained in Women's Testicles, and in those of other Females, have not so much of this Nourishing Liquor in them; because these Eggs being once fallen down into the *Matrix*, do immediately receive their Nourishment from the Mother.

The Females then of all Animals have Eggs which are nothing else (as was said before) but those little Bladders which are in their Testicles, which as soon, as they have been quickned by the Seed of the Male, do presently slide down into the *Matrix*. If one examineth well the Testicles of Females in Animals, one may perceive that they do in a manner resemble the *Ovaria*, or Egg-Cases of Birds, one may see there, a Heap of little Bladders, full of a certain serous, and transparent Liquor, each Bag, or Bladder being furnish'd with a particular Membrane for it self. Now all these little Bladders are enclos'd in certain little Cases, which are form'd from the *Fibres* of that Membrane that belongeth to the *Ovarium*, the Coats in which they are wrapped up. Which sufficiently sheweth

eth us, the difference that is betwixt the *Ovarium* of Birds, and that of the Females of other Creatures.

But this difference, as we plainly see, is but small, since they are still Eggs, which represent a Bunch of Grapes, which in the *Ovarium* of a Woman and other Females, is covered o'r'e with a thick and strong Membrane, and in the *Ovarium* of Birds with a very thin, fine Membrane. In young Maids, the Bladders of their *Ovaria* are very small, and in a manner like Millet-Seed. In those who are something advanced in their Age, they are much bigger, because they always grow bigger by little and little. In Women, who have once conceived, they are yet much bigger, but less transparent, because more disordered. They are sometimes separated from their Cases, and fall into the *Tubes*; the Breach or Hole, which they make in the Membrane of the *Ovarium*, remaineth always open, especially a few Days after the Venereal Act: So that if one could be so happy as to dissect one who died soon after her Conception, one might find that Membrane torn. Besides let no one imagine, that these Eggs owe their Origen to the Seed of the Male; they are always to be met with in all Females, and as well in those, who are but just born, as in those who have been any ways influenc'd by the Male. It is true, they are very small in young Maids, but as we have observ'd before; by little and little they grow bigger, and at last, are qualified to receive the Seed of the Male, in order to their being quickened. In Chicken, which are but just hatched, the Bunch is already entirely formed; the Grains of it appearing no bigger than Millet-Seeds, and are often so small (according to the Observation of a famous *English* Author *) that ^{Harvy's exercit. 3. p. 10.} it is impossible to distinguish them, without the help of a Microscope.

These little Bladders grow always by little and little, by Vertue of a certain Liquor which they receive from the Spermatick Arteries. These Vessels after a Million of turnings and windings, are at last terminated in the Testicles, over the Membrane of which, as also on that of each little Bladder, they are variously branched, and wonderfully interlaced, or woven. Now whether these Vessels do immedi-

ately shed their *Lympha* into those little Bladders, or immediately by the help of certain little Glandules, is a point not yet absolutely determined : Yet we are very ready to believe, that there are some small Glandules in the *Fibrous Texture* of the Membrane of the *Ovarium*, or Egg-Case, for the filtrating of this Liquor.

* V. Mr. Lamy in his Discourse against the Opinion of Eggs.

* Diemorbroeck, &c.

This new Doctrine of the Generation of Animals, tho' it be supported, and confirmed by a world of Experiments, hath yet met with some who have positively denied it, and even now there are some who oppose it. An Eminent Physitian hath look'd on it as a ridiculous Opinion, and a pure Paradox; he supposeth, as many others also do, that the Woman as well as the Man, produceth a true Seed, which is not in the form of an Egg, but is a seminal Liquor, which mixeth it self with the Man's Seed at the bottom of the *Matrix*, and which contributes to render her fruitful, when it stayeth there, and doth not flow out. He bringeth many Reasons to establish the Difference there is betwixt Birds and other Animals; he asserteth, that all Volatils have but one *Ovarium*, and that the Females of other Animals have two. He adds, that there are no Eggs found in old Hens, and that their *Ovarium*, and Tube, are both dried up, and sometimes cannot be found at all, whereas in old Women, the *Ovaria* and Tubes always remain in the same State.

But that which Monsieur Lamy, and many others also, take for Seed, is no such thing; for the serous Liquor which floweth off in the Venereal Act, is sometime plentiful enough to fill up more than half the *Matrix*; how is it possible then that it should be derived from the Testicles? Besides, Women always lose abundance of this Liquor, whether they Conceive, or no; which yet would not be so, did their Liquor any ways contribute to the forming of the *Fetus*. It hath been demonstrated long ago, that this, their pretended Seed, is only a *Lympha* that is filtrated thro' the Glandules of the *Vagina*, or else that it is carried thro' those Pipes or Conduits, which the famous *Malpighi* calleth; *The Tubes of the Matrix*, as we shall immediately shew you.

As for the other difficulty of Mr. Lamy, viz. That Women have two *Ovaria*, or Egg-Cases, and Birds but one, he should have observed, that many Animals have many Young at one Birth, as Cats, Rabbits, Sows, &c. which yet have no more than two Testicles, as well as Women, and thus he is out in his way of reasoning. He did not observe that Birds, tho' they have but one *Ovarium*, have yet more Eggs than Women, or other Females have in their Testicles.

In short the Reason is evident, why the *Ovarium*, and *Oviductus* in old Hens are worn out, and why they are not in Women. Hens, and most of the others Birds lay Eggs without the assistance of the Male, but Women seldom have any without some precedent Congress; or if they have, they become unfruitful and come to nothing (like the Eggs of those Birds, who yet never knew the Cock) and at last are carried off with their Menstruals. The reason why in old Women, the Testicles and Tubes do not disappear as they do in old Hens, is this; that in the *Ovaria*, (or Egg-Cases) of old Women, there do always remain Eggs enough to prevent this shrivling up, or disappearing of those parts. Besides, if we reflect, that all the Parts of the Body do naturally dry up, and wither with old Age, the reason why the Tubes are so soon effaced in old Hens, is very obvious; for this part in them, being more Membranous or Skinny, then the *Ovarium* and the *Matrix* (when the Hen hath once laid so many Eggs, that there is nothing left in the Bunch) must necessarily wither, and entirely disappear. Now this cannot happen to a Woman, because her *Matrix* (being thick and fleshy) cannot be so soon dried up, as being furnished with Vessels enough for its continual Nourishment: The same thing may be said of the Tubes, which are only the production of the other.

As in those Eggs, which the Hen hath sat on, there is contained every thing that is necessary for the forming of a Chick; so also in the Eggs of Women, which have been once quicken'd with the Seed of Man, is contain'd every thing, that is necessary for the forming of a *Fetus*. For there, may you visibly perceive the two Membranes, in which the *Fetus* is wrapp'd up, with the *Placenta*, or Womb-cake,

and in the Liquor of the Egg, one may distinctly observe the First rude Draughts of an *Embryo*! So that when the Egg is once fallen down from the *Ovarium*, thro' the Tubes into the *Matrix*, all the Nourishment the Egg receiveth cometh from the Mother, but as it takes not a root at first, it hath been observed, that the Egg always contains in it some small Nourishment for the growing of the *Embryo*: For the Eggs of Animals as well as those of Birds, or Fowl, have something in them of white and yellow, tho' not in that large quantity as those of Fowl; because that small quantity of Liquor which furrounds the *Cicatrix*, in the Eggs of Women and other Females, is sufficient for the Nourishment of the *Fetus*, till the *Placenta* is fastned to the *Matrix*. But in the Eggs of Birds or Fowl, there is good store of white and yellow for the Nourishment of the Chick, because the Eggs are sate upon by the Hen, and the Chick is never hatch'd, till all the white and yellow is consum'd.

The roots of the *Placenta* belonging to the Chick are fastned in the Yelk, to drain from thence that Nourishment which passeth thro' the Navel-String, and the white which in New-laid Eggs, (is nothing but Milk) as it were, runs into the Bill of the Chick, in order to its further growth. Do but open the *Gizzard*, or Intestin of Chicken newly hatched, and you will find them full of a certain Liquor like curdled Milk. You may always find the same Substance in the Stomach, and Intestins of a Humane *Fetus*.

* Vi. Harvey, of the Nourishment of Chicken.

Vi. Fabricius ab Aquap. Operations.

Vi. Bartholinus Centurics.

* It is the Mother then, who furnisheth all the Matter, or Stuff for Conception. The Father contributes nothing towards it, only the most spirituouse Parts of his Seed rise up to the *Ovarium*; for one cannot imagine, that all his Seed is necessary to make the Eggs fruitful, since it often happens, that the Seed doth not so much as enter into the *Matrix*; Nay we have many Instances of Women who have proved with Child, by having their outward parts only gently bedewed, without any further Approach. A young Mare, which had been Pad-lock'd to prevent her being cover'd by the Stallion, yet foaled, and was at last found with a Colt by her side. By the violent efforts it made to get out, it broke down the Walls

is of its Prison. This sheweth us, that an absolute Penetration is not always necessary, to render a Male Fruitful: * For they sometimes conceive, by having their outward parts rubb'd so, as that they may suck in part of the Seed.

Vi. Harv.
Exercit. de
partu p.
346.

To shew you, that the Seed of Animals doth not enter into the Cavity of the *Matrix*, do but view the Figure of the *Matrix* of Animals, and you may be satisfied. That of the Hen is long and winding, there is a great distance from the *Oviductus* to the Laying of Eggs, so that one can no wise conceive, that the Seed of the Cock, whose Instrument is so small and so short, should reach thither. In Conies, Sheep and Cows, the *Vagina* of the *Matrix* is very long. It is not straight, as it is in Women, but it has several turnings and windings, particularly in Cows, besides the inward Orifice is stopp'd up with a certain thick Glue; so that you see it is impossible for the Seed to enter into the *Matrix*.

Let it not surprize us, that so small a quantity of Liquor that is in the Egg, should yet be enough for the Generation and Nourishment of the *Fetus*; since at the first few days, the *Fetus* is only a small *Embrion*, which wants only some small quantity of the *Lacus Nutritius* for its growth. It is true, that in order to this growing, it is absolutely necessary, that the Spirits of the Seed do modify the Egg; for we see plainly, that in the Eggs of such Hens as the Cock hath carested, the *Cicatrix* is fuller, and more extended, than it is in abortive and unfruitful Eggs; which purely ariseth from that Fermentation, which the Spirits of the Seed do produce in the Liquor of the Egg.

When the Spirits of the Seed are said to contribute towards the Fruitfulness of the Egg; we do not mean, that this is done by any Incorporeal Virtue as *Harvey* would have it; but that the most subtil and most refined part of the Seed quit the grosser parts, in order to filtrate themselves into the spongy Texture of the *Matrix* and Tubes, even to the *Ovarium*, for the Quickening or Vivification of the Eggs; For the *Matrix*, the Tubes and *Ovaria* being all of a spongy Substance, are therefore the fitter to imbibe the Spirituous parts of the Seed.

We

Aristotl.
Generati.
of Animals.

We should observe here, by the way, that Males of all Creatures, even amongst Fish and Serpents have Stones, or Testicles (which some deny). If it is urged here, that even those Animals which are gelt, do yet retain Seed, and are capable of Generating: This their Seed proceedeth from the Spermatick Vessels, for the Seed, which Men and other Creatures eject in the Venereal Act, cometh not immediately from the Testicles, but from the Seminary or Spermatick Vessels, where it lyeth stored up sometime for a long while. The Seed is a very Active, and penetrating Nature, since the small quantity the Cock giveth in his Amours, is yet sufficient for the fructifying of several Eggs at once. So it is in Butterflies, whose Seed is so penetrating, that it doth fructify abundance of Eggs at the same time,

Besides, there cannot be a more pregnant Instance of the Activity and Force of the Seed than this; that several Women and other Females have conceived by a simple rubbing only, as it hath been said before. But nothing can give us a clearer Idea of the very Activity of the Seed, than the Similitude, which is betwixt those Parts which prepare the Seed, and the Brain. These two parts in short, have in a manner the same Structure; they both consist of several small Pipes which suck in the most spirituous parts from the Mass of the Blood; and so we may say that the Testicles are in a manner a second Brain, since they do filtrate as the Brain doth, a Liquor which is almost as penetrating, and as spirituous as the Animal Spirits.

Tho' it is a difficult matter to determine, where the Spirits of the Seed act in Generation, yet in all probability, we may be assured that it is in the Ovarium; since there is nothing to be found in the Matrix of those Females who have conceived, it evidently follows, that the Seed hath passed even to the Ovarium. When we speak of Seed, we mean the most spirituous parts of it, as hath been observed before, for the remaining part is lost, and runs away outwardly, besides the change which happens to the Ovarium, is a great Argument of that Effect which the Seed hath on it.

Whereas

whereas all the small Bladders are not equally
 ed to the *Ovarium*, and that some of them hang
 loose than others in their Cases; if by chance,
 spirits break off two or three of those which are
 loose, they will be forced from the *Ovarium* into
 Tubes, and from thence into the *Matrix*, where
 ing themselves, and being as it were unfolded,
 will form several *Fetus*'s, as it sometime happen-
 to Women.

Twins may also proceed from a double Egg, that
 all have two *Cicatrix*'s, or Buds. These two
 s, each of them shall have its distinct common
 membranes: Hence are generated those monstrous
 ticks which are double, and commonly fasten'd
 each other by the Back. Most of these Animals
 e not, but die soon after their Birth.

If you would conceive how the spirituous parts of **Harvy**
 e Seed do loosen, or separate the Eggs from the **Exercit. II.**
Ovarium, you must reflect, that when once the
 ed hath penetrated them, it causeth the Liquor,
 which is in them to Ferment, as Leaven doth Dough
 Past. This Fermentation swelleth and stretcheth
 the little Skin of the Egg, so that it quits its Case,
 and the Membrane of the *Ovarium*, by its Contracti-
 on forceth it outward.

Now let us consider a little how the spirituous parts
 of the Seed of the Male do reach the *Ovarium*. Some
 think it is by way of the Tubes, others, that it is
 by Circulation. They who hold the first Opinion,
 urge that it is a sign, that the Seed riseth thro'
 the Tubes, because there is always some part of it
 found sticking to the Side of them; but this is no
 Seed. For this kind of Liquor is always found
 even in the Tubes of those Females which never
 knew any thing of the Male. 2d. The Seed enters
 not into the *Matrix*, as we said before, the inward
 Orifice thereof being stopp'd up by a certain Gluish
 Matter, and that in Women, as well as in the Fe-
 males of other Creatures. Some Years past, they o-
 pen'd a Young Lady at *Versailles* who was six Months onis. in his
 gone with Child; they found the inward Orifice of *Anatomi-*
 the *Matrix* stopped up with a thick yellowish Mat- cal History
 ter which was grown very dry. We shall endea- of an ex-
 your in the following Discourse, to discover whence traordina-
 this ry *Matrix*;

this Liquor which stoppeth up the inward Orifice of the *Matrix*, which wetteth all the *Vagina*, and sometime floweth in the Natural parts of Women and other Females, that burn with Lust, taketh Rise.

Moreover this gluish Substance, which is found in the Tubes is not properly Seed, as *Graef* hath maintained; but it is rather a thick *Lympha*, filtrated from those Glandules which are in the Membrane of the Tubes, which maketh the passage smooth and good for the Eggs. In a Hen it furnisheth the white of the Yelks, for as it passeth into all the little Cells of the *Matrix*, this white Substance cleaveth to the Yellows. There are certain large Wrinkles in this *Matrix*, which go across it; there droppeth continually from them a thick gluish Liquor, which forms the White of an Egg, in fastening it self all about the Yelk, as it rowls about from one little Cell to another. Thus the Yelk of an Egg encreaseth and groweth bigger by taking the White to it, even in the same manner, as the Eggs of Fish and Frogs grow big by the froth of the Water, together with the Spawn and Seed, which the Male hath shed on the Eggs, which gathers all about them. In fine, there is some reason to think, that the white of an Egg exciteth a kind of Fermentation in the Yelk, that contributes towards the perfecting of the Egg.

So may we say also, of those little Bladders which get loose from the *Ovarium* of Women, for as they are sometime in falling down from the Tubes into the *Matrix*, the Skins of them being very fine, delicate and porous, they are very fit to imbibe that Liquor, which doth always bedew the Tubes, and to furnish White for the Yellow, as it happeneth in Birds.

They who are of an Opinion, that the Seed passeth thro' the fine Texture of the Vessels belonging to the *Matrix* into the Blood, in order to reach the *Ovarium*, have more reason on their side, than they who will have it to pass thro' the Tubes, yet this Opinion is not without its Difficulties: First, it is hard enough to conceive, how so small a Portion of Seed that mixeth it self with the Blood should do so, without losing its Energie, that seeming too long a course

for it: It is then more plausible to think with
 pi, that the most spirituous part of the Seed
 ed into the spongy Texture of the *Matrix*,
 bes, even as far as the *Ovaria*, just as Water
 ted thro' a piece of Cloath. This Seminal
 by swelling up the *Matrix* afterwards, produ-
 the Changes which are observ'd there; it is
 rit which bringeth the lower end of the Tubes
 e *Ovarium*, and as all this purely ariseth from
 rmentation of the Nourishing Liquors, the
 of these parts must necessarily be irritated, or
 d by it: It is this also, that determines the A-
 Spirits to flow into these Parts, as we shall af-
 ds make it appear.

One may here plausibly object, that this Sero-
 ich always wetteth the *Vagina*, and which
 mes so much aboundeth in the Venereal Con-
 must needs hamper, and embarrass the Spirits of
 ed, and so give a great check to their Activity;
 e must observe, that the Liquor which is fil-
 thro' the Glandules of the *Vagina*, is so far
 osening the force of the spirituous Parts of the
 that it rather augments it in a great degree, it
 also of a spirituous Nature; for in going be-
 as we may so say, the spirituous Particles of
 ed, they are mingled, and ferment together;
 short, the most subtle parts are carried even
Ovaria, thro' the spongy Texture of the *Ma-*

ey who are desirous to have a more particular
 ont of the Use of all the Parts of the *Matrix*,
 e Source of this Liquor, let them well consider
 is contained in the Learned and Curious Let-
 Mr. *Malpighi* to Monsieur *Spom*. He saith,
 be Structure of this Part is so much disturbed, as
 efore, as after their Time of growing big, that
 n hardly distinguish it, or make a true Observa-
 it; but that the most critical, and most favourable
 e for the examining of this Part, is then when
 atrix is full, particularly that of Brutes, and more
 ally that of a Cow; because that being then very
 be Parts of it appear more visibly, and more
 ily.

The

The Membrane which covers this *Matrix*, also of a Woman's is very thick; the *Matrix*, and the *Vagina* are wrapped up with it, there are certain fleshy Fibres under it, which are very soft but not ranged in the same order; For near the *Uterus* and the *Ovaria* they run cross each other, being gathered together in Bundles.

There are also other *Fibres* which run in an horizontal Line, according to the thickness of the *Matrix*, they are fasten'd to certain, thin and small Membranes which cover the *Matrix*, tho' not the same Plain or *Basis*. These *Fibres* have several *Lymphaticks* belonging to them, which are full of certain Liquor that evaporates being set on the fire, which happens not to the *Lympha* of other *Lymphaticks*, since it commonly thickens.

Under these *Lymphatick* Vessels, there are several *Veins* and *Arteries*, which enter the *Matrix* in several Places, and thereby compose an admirable Net-work, each Branch is often attended with two *Veins*, and all the foresaid Lacings have several *Nerves* belonging to them, which have the same Course.

Besides the *Vasa Sanguinea*, there are also several *Pipes*, which *Malpighi* calleth *Tubes*, which are very remarkable when Females are big, and especially in Cows: You must have a great deal of patience to follow the Progress these Vessels make, they are attended along both the sides of the *Matrix* and the *Vagina*, even to the place where the *Matrix* touches the Bladder.

Tho' these *Tubes* reach from the beginning of the *Vagina* to the *Uterus*, yet they do not retain the same Figure, the same Bigness, nor the same Course; the lower part of them, which ends towards the *Uterus*, just under the Membrane, which covers the inside of the *Vagina*, tendeth straight upwards to the *Matrix*; one can scarce put the point of a Bodkin into the Orifice. But the Orifice of these *Tubes* is for some time so large, that one may sometimes thrust the end of ones little Finger; then they open into the *Vagina* above the *Ureter*. The Orifice of these *Tubes* lies hidden within the Wrinkles of the *Vagina*, where it formeth a little Nipple. These Pipes are for

ed one with another, that they cannot be separated from each other without a great deal of Dexterity, because they are often so small, and so obliquely placed, that one cannot see them; yet when they are full of Liquor, they appear very plain and sensible enough. The *Tubes* which arise from the Neck of the *Matrix* on the fleshy *Fibres*, run always all o'er the bottom of it, and all about the sides; they bedew the inside of many small Vessels which are dispersed, and as it were lost within the *Matrix*. There are certain little Glandulous Bags in the Orifice of these *Tubes*, with many little Membranes a cross them, like so many *Valve's*. Some are like the uneven Knobs in the Colon. These Vessels are larger towards the *Ureter*, being open in several places of the *Vagina*, as we have observed before. Those *Tubes* which are on the sides of the *Matrix* are cover'd with a Cartilaginous Membrane, which makes them look as if they were Varicous, or as if their Veins swollen or dilated. Those of the *Vagina* are as big as a Pen, being cover'd also with a very thick Skin: Make an Injection into these *Tubes*, and it goeth but a little way because of the gluish Substance, with which they are filled. They are so big and so long in Cows which are with Calf, that some of them are half an Ell-long.

The Liquor, with which they are filled, is a yellowish Juice; it is not of the same consistence in all these Pipes which are spread about the *Matrix*; it is also very different in the different Species of Animals. For Example in the *Vagina* of a Cow, which hath several Windings in it, this Liquor is thick, and a gluish Substance, like Pap half boiled; and in the other Branches of the *Tubes* which spread up and down the *Matrix*, this Juice is like Turpentine. If it is put o'er the Fire, it riseth up into little bubbles, which shows, that it is full of Air or Wind; there remains at last a Coat on it like Glue.

These Vessels appear best when the Bladder is separated from the *Matrix*, and the Membrane that covers them, one may trace them even to the *Tubes*. The Liquor is often so transparent, that one may easily see them in the *Vagina*. These, saith *Malpighi*, perhaps are those Vessels, which the Antients took

took for the *Vasa Deferentia*, which *Laurentius Riolanus* speak of; *Graef* also calls the Orifice of the Vessels *Lacunas*, Ditches or Channels, which terminated in the lower part of the *Vulva* to catch thither, that whitish Liquor which floweth in Amorous Combat. He saith, that in all probability they are those Vessels, which *Caspar Bartholinus*, calleth the Prostats of Women.

In fine, according to the Experiments of the more elaborate *Malpighi*, steep for a while the *Matrix* of a Cow in Water, and all the Excretory Pipes of do more sensibly appear; they are very plain also in the Sheep. Now whether these *Tubes* have Glands for the filtrating of the Liquor that is in them or no, this is a point that doth not yet sensibly appear: Yet according to those Laws, which Nature follows in the filtrating of Liquors, they may be supposed to have some. The reason why we see them more in the Cow, is, because they are small, this is what we find when we dissect the *Matrix* of a Cow that is with Calves. Thus by examining and observing the Parts of other Animals, we may more easily, and more perfectly understand the Structure of a Humane Body, and the Parts thereof.

The *Matrix* of a Woman being much less, and of a closer Substance than that of a Cow, and other great Animals; Thus it appears in a Woman which is several Months gone, all o'er the Body of the *Matrix* there appear certain Vessels, which being twisted one within another, do form a kind of a Lace or Net-work. It is a Fingers breadth thick, under its Membrane there are seen several fleshy *Fibres*, made up like so many little Bundles; and so is it also in the inward part. There are abundance of Cavities, which are form'd into certain Vessels, whose Membrane is fine and delicate; The Circumference of their Orifices are so formed, that by an *Anastomosis* they open into each other. One may observe the same kind of Mechanism in the Vessels of the Breast, and in those of the Nut of the Yard. There is Blood in those Cavities, and one may perceive there some small Ramifications of Veins, like those in the Spleen. When the *Placenta* or Womb-Cake, is separated from it, the inside of the *Matrix* seemeth all *Musculous*, with a great

great many *Vasa Sanguinea*, or Vessels for carrying the Blood.

As for the *Tubes* of the *Matrix*, tho' they are not so apparent in Women with Child, as they are in Cows, yet they have the same Office, or there is the same use for them. The Liquor which they contain, saith *Matpighi*, apparently serveth as a Vehicle for the Spirituous Parts of the Seed, and the Fermentation of the Seminal Parts with this Liquor, communicates it self to the *Matrix*, and to the Liquor in those *Tubes*, which are spread up and down in the *Matrix*, whence all those Changes or Alterations in the *Matrix*, and in all the Nourishing Juices; Thus the Egg being once got into the *Tube*, may be wet, or bedewed with the more Subtle Part of the Seed, which are in Fermentation; this, perhaps, made *Hippocrates* say, that those *Matrixes* which were too dry, or too moist, were barren; for in the first, the Spirituous Particles of the Seed, for want of a just Vehicle, cannot penetrate a cross the *Matrix*, and in the other they lose their Activity by too great a Moisture, so that those *Matrixes* which are temperate, are only fit to make Females fruitful.

Nature which every where observeth the same order, hath made use of the same Mechanism in Insects, there is a great Bladder, with two *Tubes* hanging at the end of the *Ovarium*; there flows from thence a Liquor into the Cavity of the *Vagina*, where the Seed of the Male is mingled with another Liquor that comes out of the Pipe on the side of the *Vagina*. It is this Mixture which perfects the Eggs by Watering them, and this Vertue may be preserved for some days, in order to be communicated to the rest of the Eggs which remain. So it is in the *Bees*, whose Eggs grow fruitful successively one after another. Besides, where the *Tubes* run all o'er the *Matrix*, and that the Liquor in them is impregnated with the Volatil Particles of the Seeds, the first Conception may be said to be in those Parts as soon as the Egg is fallen down there, there it receiveth Nourishment from the White, which it gathers up as it passeth along, as we have already observ'd.

What the
Whites
are.

Nothing sheweth more the use ascribed to this Liquor, than those Changes it undergoeth, when a Woman lieth with one who hath the Venereal Distemper; for in one night's time only it may be so altered, as that growing acid, it may be presently communicated to all the Parts with the Poison hath receiv'd. There is reason also to believe, that what is commonly call'd the Whites in Women, is only an overflowing of those Liquors proceeding from the relaxation of the Glandules, and excretory Pipes, which may be occasion'd by several Causes which we shall examine in another place.

The Egg being once slipped down from its Ovary into the *Matrix*, it is again bedew'd with the Liquor that is well charged with the more Spirituous Particles of the Seed of the Male: The *Matrix* swelleth yet more, and the *Cotyledons*, or Orifices of the Vessels or Veins which fasten the *Fetus* to the *Matrix* are puffed up, and all the nourishing Liquors are in a greater Ferment: This is that which unfolds and as it were unlocks all the Parts of the *Fetus*: this is that which renders it more sensible, growing every day bigger by the constant nourishment it receiveth.

Plazzonius.

It is no easie matter to explain in what manner the more Spirituous Particles of the Seed do contribute towards the making of the Egg fruitful; Some look on the Seed of Man as an *Acid*, and that of a Woman as an *Alkali*, which being mix'd together, do raise a kind of Fermentation. There are others who compare the Seed of Men to Flower, and that of a Woman to Water; they say that a kind of Paste is formed by them, which is afterwards modified by the *Virtus Formatrix*, in order to Form, a *Fetus*. In short, others are of Opinion, that the *Fetus* is formed in the Egg by the Particles of the Seed which are there hamper'd by losing their Motion. But this Opinion carrieth no probability with it, for how should such Subtle Particles as the Spirits of the Seed are, thicken themselves in the Egg so fast as to form a Body so firm and so solid, as the *Fetus* is? It is more probable then, that the Fruitfulness or Fecundity of the Egg is to be ascribed to that Rapidity or Swiftnes, with which the Spirits insinuate themselves

themselves into the Egg, to unfold all the Parts of it at once, in opening all the Pipes, which may receive the Nourishing Juice.

We must yet confess, that this Motion is something obscure in its self, and that it is impossible to determine exactly and particularly in what manner the Parts of the Egg are thus unlocked, or unfolded: But yet it is certain, that it happeneth as it hath been said by the most Spirituous Particles of the Seed of the Male, which by the different Figures, and different degrees of Motion they have, must needs, by penetrating the Matter, or Substance of the Egg, open and as it were unlock its parts, and so from that *Chaos*, raise the Body of an Animal.

This Motion without doubt, is not perform'd without a Rarefaction in all the Particles of the Egg, which makes it swell, but when this Fermentation is over, the Egg immediately groweth less; it sinks down, because there riseth all about it a certain Glandulous Substance that presseth it on all sides. *Ma^r Graef*, ny are of Opinion, that it is by it, that the Egg is forced from its *Ovarium*, because this Glandulous Body surrounding it on all sides, and by pressing it very hard, it drives it thro' the little Hole that is in the middle of it, which they call the Nipple. But it is more probable, that this Glandulous Body is formed of a part of the Liquor of the Egg, which is precipitated by the Fermentation of the Seed. Thus this Nipple is to be looked on as a Filtre to strain the Matter which is to form the Egg. Besides, if this Kernel was designed for the driving out of the Egg, by its Contraction it would be Fibrous; but it is in a manner like the Substance of the Kidnies, it is not this then, that so presseth the Egg as to drive it out, but it is rather the Cover of the Testicle, whose Fibres being strongly contracted, do press and bind this Kernel, and bringeth its Nipple against the Membrane of the Testicle, which being once broken, the Orifice of the Nipple visibly appeareth.

This Contraction happeneth not without squeezing together the *Vasa Sanguinea* of the Egg, it therefore leaveth the *Ovarium*, because all those Vessels

Vas Umbilicale. which were the Stalk to support it, are become dry and wither'd. This *Pedicle*, or Stalk is still call'd, the Navel Vessel, one seeth the same thing in the Eggs of Plants; the end of the *Vas Umbilicale* groweth bigger and swelleth, by vertue of the Liquor that enters into it; this is it which rendereth the Plant visible.

After the Egg is got out, the Glandulous Substance grows less, by little and little, and at last wholly disappeareth, just as the Kernel and Bowels are dry'd up, by the shrinking of their Vessels.

Lames. We must not wonder then, that the Egg which is so strongly fastned to the *Ovarium* should be separated from it, since the Vessels which brought it its nourishment, are dry'd up and faded, and that its *Calix* or Case being brought into a narrower compass by the Contraction of its *Fibres*, drives it out thro' the Hole that is in the Membrane of the *Ovarium*. They who deny there is any such Hole or passage, and assert that *Graef* in this point is deceived, and maliciously deceiveth others, contradict Experience, which sheweth us that this Hole is always to be seen a little before or after, that the Egg hath passed thro' it, and even in some Animals, it continues open till the Birth of the *Fetus*.

The Egg upon the quitting of the *Ovarium*, is receiv'd in at the lower end of the *Tube*, which safely conveyeth it into the *Matrix*, just as a Hen's Egg passeth into the *Oviductus*, in order to pass thence into the *Matrix*. But the *Tube* is admirably contriv'd for its Motion, and for the bringing what they call *Morsus Diaboli* near the *Ovarium* to prevent the Eggs falling into the Belly.

For the clearer explicating of this Motion, we shall observe, that the *Tubes* consist of a spongy substance, and in a manner, like the hollow parts of the Yard. Thus when the Spirituous Particles of the Seed come to moisten or wet this *Filtre*, the *Tubes* thereupon immediately swell, and are stiffly bent: But as their Tension, or bending, instead of bringing them nearer to the Testicle, doth rather force them to a greater distance from it, the active *Fibres*, which they receive from the Membrane of the *Ovarium*, with their large Ligaments also, serve as so many

Bridles

Bridles which raise them up again, and bring them near the Testicle, for the receiving of its Egg, and for its easier entrance into the *Tube*, the broad end of it makes a kind of a Fringe, which squeezezeth the *Ovarium* together, as with so many Fingers to force the Egg thence, when it is come to Maturity, as soon as it is entered the *Tube*, the Peristaltick Motion of this part, which is performed by the Muscular *Fibres*, makes it descend by little and little into the bottom of the *Matrix*, in order to be kept warm, cherished and nourished as any Grain is in the Earth.

But as it is well known, this Egg, which thus falls down into the *Matrix*, receiveth not its Coats there, but is all cover'd or cloathed on its quitting the *Ovarium*, to the end, that the *Fetus* may have sufficient nourishment, during the first days. This Liquor in which it swimmeth, also prevents it being bruised against the *Matrix*. Thus you see the Covers or Coats of the Egg serve as well to contain a certain Liquor for its immediate Nourishment, as to defend the tender and delicate Substance of it, against the Motions of the *Matrix*. According to this Hypothesis one may easily explain, how *Twins* are formed, for even as one Grain of Seed produceth only one Tree; so also one Egg contains but one *Fetus*, when two appear, or that you see a double *Fetus*, arises from this, that two Eggs are separated, or loos'd from the *Ovarium*, and descend into the *Matrix*; even as two Grains are necessary for the making of two Plants. It is not yet impossible, that one Egg should have in it two *Fetus*'s, as we see one Grain of Corn doth sometimes push forth several ears; because this may be a double Egg, and contain in it self, Two *Cicatrixes*, two Yelks, and two Whites, as we sometimes find in Hen's Eggs, whence two Chicks are always hatch'd, as it hath been observed.

It appeareth from all that hath been hitherto said of Generation, that the *Germina*, or Buds, are contain'd in the *Ovarium* of the Females, but yet there are two new Opinions started upon this Subject: Cevenagh
The first pretends, that these Buds or Blossoms, were formed in the Testicles of the first Male: The se-

cond will have it, that they are scattered thro' the whole World, so that there remains some of all kinds every where, and that being swallowed down with our Food, they are at last particularly fasten'd to the *Ovaria* of their proper Females.

Tho' this last Opinion is not directly contrary to the Laws of Nature, it is yet true, that it is more intricate and obscure, than that which supposeth that the Buds are contained in the *Ovarium* of the Females. For what shall prevent these Buds from being corrupted by the Digestion of the Stomach? Besides, it supposeth, that some particular Causes are necessarily required for the uniting of them to the Females of each Kind; whereas according to the Opinion of those, who suppose those Blossoms shut up, or contain'd in the *Matrix* of Females, this Union is performed at first by the same Action that forms them.

They who assert, that these tender Buds were formed in the Testicles of the First Male of each Species of the Creation, build their Assertion on Experience. For by observing this Liquor with a Microscope, the Seed of all Males seemeth to be full of small Living Creatures. To what end say they serve these little Creatures, if the Seed of the Male doth no otherwise contribute to Generation, than by the Fermentation it raiseth in the Egg: Therefore they are rather inclin'd to believe, that those first Buds or Sproutings are those little Creatures we discover in the Seed, than to be any ways perswaded that Fathers contribute so little to the Generation of their Children.

That which seemeth most to thwart this Opinion is this, That the Seed of Males being full of many little Creatures, must needs contribute to the making of a great many little ones, as oft as the Female should enjoy the Male, which yet is not so. For we see that many Women, even after frequent Enjoyments, have yet no Children, or if they have any, they have but one. But this Objection is easily answered by the Champions of this new Opinion: they say, that the Eggs of Females are as so many *Matrixes* appointed for the nourishment and growth of those Buds which the Males furnish. They add

that these *Matrixes* are not always disposed for the receiving of these Buds: So that it is no wonder, that there is not always some Animal Generated, as often as the Males furnish their Seed; or that Women, when they do Conceive, should yet produce but one *Fetus*, tho' the Seed, which hath passed even to the *Ovarium* be impregnated with an infinite number of Buds.

Mr. *Harfoeker* told me, that it is about seventeen or eighteen Years since, he was the first that made this Discovery. It is thought that *Monsieur Hamburg*, a Member of the Royal Academy of Sciences will publish some particular Treatise on this subject. But as this Hypothesis is not to be established without many Experiments, we shall insist on what hath been at first proposed.

To conclude this Chapter, we shall now consider, whether the Seed of the Male (as many do pretend) is the true cause of all those Changes and Alterations which happen to Women and other Females, by its being circulated with the Blood. It is said, that the Flesh of Animals killed a little after their Conception, is much different from what it was before; because the Spirits and Humours being heated by the Seed, and thereby grown more penetrating, do open the Pores of all the Parts, and especially those near the *Matrix*, where those Vessels which convey the Nourishment to the Eggs are determined, or end: In fine, (according to the Notion of those Men) the Reason why Women after their Conception are sometimes troubled with such strange Symptoms, as Delirium, extravagant Longing, Vomiting, and nauseating Feavers, and Inflammations of the Womb, &c. is this, That their Blood is filled with the parts of the Seed. For what reason can there be given for so many Accidents, if it ariseth not from the mixture of the more Spirituous Particles of the Seed with the Blood, which puts it into a Fermentation.

But yet we must shew you, that all this may happen, or be performed after another manner. First. It hath been asserted, that the Seed did only wet, or moisten the *Matrix*, as Water doth a *Filtere*, and that it did not pass into the Blood at all. 2d. It hath

*A new Con-
jecture on
the Symp-
toms of
Women, and
the Females
of other
Creatures
after their
Conception.*

been shewn, that the Seed being mixed with the Liquor that is in the *Tubes* of the *Matrix*, there happeneth a Fermentation which swelled all those Parts, and that their Irritation of the *Fleshy Fibres* disposed or determined the Animal Spirits to run into these Parts, and that the *Tubes* thereby grow stiff; that the *Morsus Diaboli* pressed hard on the *Ovarium*, &c. now those Motions of themselves are enough to irritate, or disturb the *Genus Nervosum*, and to create an irregular and disorderly Motion in the nourishing Liquors. But as the Fermentation, which at first began in the *Matrix*, continues for some days, the Membrane of the *Ovarium* at last is torn, which is occasioned as well from the compression of the Nipple, as by that of the *Fibres*, which belong to the Circular Mussels of the *Calix* or Cup, in which the Egg is, as it were incased. This violence on the Membrane of the *Ovarium* is commonly attended with some pain, which a-fresh determines all the Spirits to flow towards that place; from thence it is, that young Women who are of a delicate Constitution, are on this Occasion apt to faint away.

In short, if they Vomit, or are troubled with Watchings, and cannot sleep, all this proceed from the impetuous and irregular course of the Spirits, as do also the other Symptoms, they labour with. But as soon as the Irritation of the *Fleshy Fibres* of the *Matrix*, the *Tubes* and *Ovarium* hath ceased, and that this their first Delivery, (as we may so say) is over, (for one may look on the Eggs passing from the *Ovarium* into the *Tube*, as the first Sally the *Fetus* makes) all these Symptoms are soon vanished, and Women after that, are generally troubled with no other inconvenience, but that they grow big and unweildy, as they come near the Time, or Hour, of their Delivery.

*Journal des
Scavans.
1669.*

Besides if the Egg by any occasion happens to stop in the *Tube*, and is there nourished till the third or fourth Month, it infallibly killeth the Mother, when ever it gets loose, because this cannot happen, without loss of much Blood. The Woman who died 1669 *January* the Fifth, was a fair instance of this kind, she had been troubled with terrible Convulsions

for three days together, and then she died, being four Months gone with Child. They then shew'd to several Persons the *Fœtus*, which was in the right *Tube* of the *Matrix*, which it had

In fine, if the Flesh of Cows, Deer or Stag is yellowish, soft or flabby, and of an ill Taste, with a rancid Smell a little after their Copulation; and Female Fish after their Spawning are worth nothing, as it appeareth by Salmon, whose Flesh from being so long in the Water, become soft, white, and of an ill Taste; we must not imagine, that all this ariseth from the Seed of the Male, which changeth the Blood, since those Alterations purely proceed from a Disease which happeneth by the Fermentation of the Liquor in the *Tubes* of the *Matrix*.

CHAP. II.

Of the Nourishment of the Fœtus:

WE have hitherto examin'd the first Principles of the *Fœtus*, or to speak more properly, its buds or blossom, since as so considered, it is only a rude Draught of what it is to be afterwards. Let us see at present how this Bud taketh Root, and how all the Parts of the *Fœtus* thro' Nourishment are by degrees unfolded. We shall begin with the Covers or Coats of it, since they first present themselves to our view.

Since the Membranes of the Egg, are what is call'd the Shell of it, it seems that they are not then form'd, when the *Fœtus* unfolds it self, but that they are of the same age with the Egg. They serve as the first swaddling Cloths to wrap the *Fœtus* up in, and to contain the Liquors which are appointed for its Nourishment. The Membranes of the Egg are easily separated after they are boil'd a little; one must go dextrously to work with the point of a Lance. The *Chorion*, which is outward most, is thick; several Vessels,

sels, for containing the Blood, are visibly perceiv'd in it. The inward, which is call'd the *Amnios*, is much finer, and more delicate, and hath not so many Vessels in it. These two Membranes always encrease, and extend themselves more and more by the Nourishment they receive.

Many Anatomists have asserted, that there was a Third Membrane belonging to the *Fetus Humanus*, call'd *Allantoides*. But Experience sheweth us, that the Human *Fetus* hath no *Allantoides*, according to the Observation of other * antient and expert Anatomists, and it hath only the *Chorion* and *Amnios*, which are two Membranes visible enough.

* Galen,
Vesalius,
Spigelius,
Plempius,
Hygmo-
rus.
Aquapen-
dens, Pa-
reus, Bar-
tholinus
senior, E-
verhardus
&c.

Some have said, that the Reason why this Membrane doth not visibly appear in the Human *Fetus* is, because it is so fine, and so delicate, that it is presently torn. But admit it were as fine as a Spider's Web, still the pieces of it would be easily discern'd. Those Authors, who admit the *Allantoides*, have yet allow'd it no determin'd place; some will have it that it is outwardmost; others place it betwixt the *Amnios*, and the *Chorion*; and others again, that it immediately closeth the *Fetus*. These different Sentiments, are as so many Contradictions, which shew the fallshood of this Opinion.

* Galen,
Vidius,
Fallopianus,
&c.

There are then the *Chorion*, and the *Amnios*, only, in which the *Fetus* is wrapp'd up: These two Membranes are, at first, separated from each other by a little Liquor that is betwixt them, as one may observe in a *Fetus* of six Weeks, or two Months old. But these same Membranes becoming afterwards thicker they take up all the space, and are so closely join'd to each other, that they are hardly separated, or with much difficulty. Thus, whatever the * Antients, and others, have said concerning the Sweat of Urine, which is within these Membranes, are downright Errors not worth the confuting: For since these Membranes are join'd so close to each other, where should these Liquors be? And if any thing is observ'd to flow in the laying open of these Membranes, it is when the *Amnios* is open'd.

As for the Flooding, or Liquor, which is often observ'd to flow out some days before Delivery, this cometh not from the *Amnios*, since abundance of it

always found in this Membrane ; but it proceeds from certain Waters, which are gathered together, then when the two Membranes are separated from each other ; for there can be no relaxation of the *Fibres* of the *Chorion*, without rendring the Pores it wider, which must needs afford a Passage for that Humour, which by little and little, shall encrease in the space betwixt the two Membranes, and which will break or tear the *Chorion* ; for this Reason the Waters will flow out.

The *Chorion* is not fleshy, as *Vesalius* thought: It is true, that it is something thicker, where the *Placenta*, or Womb Cake is ; and this perhaps gave him occasion to say, that this part was fleshy. We must now explain, after what manner the *Embryo* is nourished, before there is any *Placenta*, or that it is fastned to the *Matrix* ; Those Vessels which float up and down in the Liquor of the Egg, are so many Pipes thro' which the more subtle Particles do rise, or mount up : But this Liquor doth not enter into these Pipes by way of Attraction, but it is carried up there purely by the Motion of these Pipes, which are always in Motion, as also from the Motion of a fluid Body, which obligeth those small Particles which are at the Orifice of these Pipes to enter, and run along in them. The Motions of the *Matrix* also contribute much to this, because in encompassing, and surrounding of the Egg, it presseth it on all sides.

From thence we see, that the Liquors already begin to Circulate in the *Embryo*, in order to reach the Heart, which by its motion distributes them to all the other parts, this is that which extends and lengthens all the Vessels. In fine, it is these repeated, and Alternative Motions which occasion this Circulating Liquor to change its Colour, and to become Blood ; because these small Particles in passing thro' all the Vessels and little Bladders which compose the Parts, grow subtle, change their Figure, and thereby acquire a certain rapid Motion which makes them turn round on their own Center, and gives them a red Colour.

When once the *Fetus* is a little nourished, and grown something bigger ; the *Placenta* is presently form'd

Mr. Mal-
pighi in
his Letter
on the Ma-
trix.

form'd, and fastned to the end of the Navel Vessels; it consists of a Glandulous and Fibrous Substance, and is designed to fit and prepare the Nourishment for the *Fetus*. During the Time of a Woman being with Child, there appear in the *Matrix* several small Nipples of a fine delicate Texture, which are fastned to the Vessels of the Womb-Cake. These Nipples consist of abundance of fine little Skins, which together compose a kind of a Net, which consisteth of small Bodies round and long, of an Ash Colour, representing the Caul of Fishes. There are also several Blood-Vessels which go to the *Placenta*, and to the *Chorion*.

There is some reason to believe, that these Nipples which are formed Net-wise, do serve as so many *Filtres* or Strainers for the carrying of the Blood, and Chyle from the *Matrix* to the *Placenta*, which is strongly fastned to the *Chorion*. This is nothing else but the joining together of the Navel Vessels; compacted or made firm by the *Cotyledons*, with which it is sheathed within the *Matrix*. Steep but the *Placenta* for some small time in Water, and these small small Branches visibly appear with the *Vasa Sanguinea*, which Water them, which formeth a Hairy Substance, like the Roots of some Trees. The *Placenta* is uneven, or rough, on that side where it is fastned to the *Matrix*, because of the *Cotyledons* into which these small Branches pass.

It is a common Opinion, and generally believ'd, that the *Fetus* in the Womb is nourished by the Mother's Blood, and that there is a reciprocal Anastomosis, betwixt the Naval-Vessels, and those of the *Matrix*. But to shew how erroneous this Opinion is, let us only observe, that for the first few days after Conception, the Egg is no ways as yet fastned to the *Matrix*, (as was said before) and towards the last Months of a Woman's Going, the *Placenta* is always separated, or divided into two thin pieces, or Plates, which are nearer to the *Matrix* than to the Coats of the *Fetus*. From whence we may infer, that the *Fetus* wants some other Liquor besides Blood. None is fitter for this purpose, than that chylous Matter, or milky Substance, which is found in a plentiful manner in the *Placenta*, and in the *Cotyledons*.

We

We must not believe that the Blood, which is carried to the *Matrix* thro' the Hypogastrick and Spermatic Arteries, doth enter, just as it is, into the Vessel of the *Fetus*, without any precedent preparation; it must first be filtrated in the Nipples of the *Placenta*, which serve as so many Glandules, to prevent any thing but *Chyle* from flowing into the *Placenta*, and mixing afterwards with the Blood of the *Fetus*, and from being carried with it thro' the *Vena Umbilicalis* into the *Vena Cava*.

Hitherto you see, that there is no great difference betwixt the Antients and the Moderns, but when we shall shew, that the *Fetus* must needs afterwards receive In Nourishment at the Mouth, there will be many who will exclaim against this Opinion. The Authority of *Hippocrates* should silence them as to this Point: In his Book *de Carnibus*, he maintains that the Infant is nourish'd by the Mouth. But we are not to be swayed by Authority, unless, when it is back'd with Reason and Experience, we take notice, that there is always some *Chyle* in the Stomach of the *Fetus*, and that of other Animals, and so also in the *Gizzard* of Chicken newly hatched.

The Ancients were of Opinion, That the Liquor of the *Amnios* was a pure Excrement, and that it was the Sweat and Urine of the *Fetus*. But the Moderns have demonstrated, that it serveth for nourishing the *Fetus* by the Mouth. *Harvey* in his Exercises proves it by many Experiments. He sheweth, that the Liquor of the *Amnios* consists of Particles which are Serous, and of others, which are Chylous and Spirituous, which last contribute to the nourishing of the *Fetus*. This is a very reasonable Opinion, for in the last Months of pregnancy, this Liquor is in a manner dried up; it is sweet, and of an agreeable Taste, which sheweth it is no Excrement. Put it over the Fire, it thickens into a Jelly, which it would not do, if it were only sweat or urine.

But the greatest difficulty is to know positively whence this Liquor cometh, some say it cometh from the *Matrix*, and that it passeth thro' these Membranes, in order to be lodged in the Cavity of them; others

Harvy's
Exercit.

56 p. 238.

others say, that it cometh thro' the little Branches the *Umbilical Arteries*, which run here and there about the Inside of the *Amnios*; and others again derive it from the Sweat of the *Fetus*: Without making any more particular Examination of all the Opinions which admit of great Difficulties, I shall lay down one that is more probable, and which is backed with Experience.

All Mid-wives know very well, that Children newly born have always their Breasts full of Milk, and sometimes in so plentiful a manner, that they are obliged to squeeze it out; because without a necessary precaution, their tender Breasts will grow hard, and then suppurate, as it often happens in the Breasts of those who give Suck, when the Milk is once curdled or coagulated. We have known Children who have sometime suffer'd from this Accident, because the Mid-wife took no Care to squeeze the Milk out of their Breasts. The Liquor of the *Amnios* then, is that serous Milk which flows from the Breasts of the *Fetus*, for why should they be so full of Milk, unless it were to empty into the *Amnios*.

Mr. Dre-
lincart,
and other
Moderns,
&c.

They who seem to derive this *Lympha* from that which flows from the Glandules of the Eyes, Nose and Salivary-Pipes, do really favour the Opinion which is here proposed: For if all these Glandules empty their Liquor into the *Amnios*, why should not the Breasts of the *Fetus* (whose Glandules are so soft and tender) discharge their superfluous Humour into the same *Amnios*? This cannot be denied. Thus the Liquor of the *Amnios* will not be pure Serosity, but a nourishing Juice, always full of Chyle; and consequently fit to nourish the Child when once it shall have been digested, and circulated round the Body with the Blood.

This Liquor of the *Amnios* is continually filtrated thro' the Glandules of the Breasts, as long as the Texture is loose enough to let it pass, but at length they grow more close and firm; and then what is filtrated thro' them, is only a pure Serosity, not fit for the Nourishment of the *Fetus*, so that towards the last Months of their Time in some Women, the Liquor of the *Amnios* is as clear as Water, and what

is put over the Fire, it will no more thicken into
elly, because it is deprived of those nourishing Par-
cles which we spoke of before.

C H A P. III.

Of the Birth of the Child.

WHEN the *Fetus* hath been nine Months in the *Womb*, it commonly leaveth that Prison in *Mr. Bayle in his History of the Women of Tholouse.* order to enjoy a freer Air, which it then wanteth, and afterwards thro' the Care of a tender Mother, and the good disposition of its Organs it thrives, and daily encreaseth thro' Nourishment.

The Women commonly go but nine Months, yet Harvy's Exerc. de- there have been some who have kept their Children in the Womb for several Years, as 'Twenty five Years, as it hath been said, even in these our Days; but those are extraordinary Things, and of which, we have but few Instances. There was also a Woman, *Galen, who at the end of sixteen Months, after she had felt the Child stir for ten Months, was happily deliver'd of a Child.

There are many Causes which contribute to the Birth of the Child, or the exclusion of the *Fetus*. Some * Authors have said, that the Child never left the Womb before it was fully and compleatly perfected in all its Parts, and fit to take in its Nourishment at the Mouth. But we have shew'd the contrary, since the Child even whilst it is shut up within the Womb, is not only nourished by the Navel, but by the Mouth also.

It cannot in any Probability be said, that the Child therefore leaveth the *Matrix* because it wanteth Food, since there is always enough for one, and sometimes for two, or more. Nor is it the weight of the *Fetus*, or the abundance of Waters in those Membranes that encompass it that occasion the Birth;

Hippoc.
Aquapen-
den, &c.

Birth; for if it were so, a *Fetus* of eight Months which is often bigger then one of nine Months would sooner be born, and not tarry till the usual Time was expir'd: So also, if the Birth proceeded purely from the Weight of the Child, or *Fetus*. The Twins of eight Months, which are heavier than one single *Fetus*, would certainly quit their Prison without tarrying for the usual Time of their being deliver'd.

Some also compare the *Fetus* to a kind of Fruit, and the *Matrix* to a Tree, even as ripe Fruit (as they) drops from the Tree in its appointed Time: so also the *Fetus*, (when it is once grown ripe) must fall from the *Matrix*. But the Maturity of the Fruit is not the only cause why it droppeth from the Tree, but it rather proceeds from the drying up of its *Pedicule* or Stalk; whereas in the *Matrix* there is no such drying up or shrivling of the Vessels; the *Placenta*, or Womb-cake, with the little string remain always soft and supple, from the Nourishment which watereth those Parts. In fine, the Child always cometh first, and then the Womb-cake; and sometimes this Part sticks so fast, that the Mid-wife hath much a do to loosen it.

Some will have it, that the Child's leaving of the Womb at such a time, proceeds from a certain Irritation communicated to it from the *Acrimonie* of the Waters, which loose their Sweetness by nourishing the *Fetus*. But tho' the Liquor of the *Amnios* is sweeter in the first Months than it is afterwards towards the latter end, it is never yet so sharp as to irritate the *Fetus*, as we may see by Experience. We must rather say, that the true reason why the Child cannot tarry any longer in the Womb than nine Months; is, That it wanteth more Air for the Circulation of its Blood, that which it receiveth from the Blood of the Mother being too little, and in too small a quantity for the Motions of its Heart, which are now become more rigorous and stronger than they were at first.

By that one may give a rational Account of Dr. *Harvey's* Problem, who asketh why a Child which is but just born, and swaddled up in its Membranes, may yet live for some Hours, and yet presently dye,

as soon as it is stripped from the said Membranes. When a Child comes just into the World it is tender and delicate, the little Bladders of its Lungs sink in, the Blood circulates gently, and with a motion proportionable to the little Air it then hath. So that when it comes to be exposed to the open Air all on a sudden, the Lungs of it at first cannot surmount, or withstand the force of the outward Air, which presseth it on all sides, which must needs hinder the Circulation.

Tho' the Efforts of the Mother, and Child together, do much contribute to her Delivery, yet Children are sometimes born without the help of their Mother, as when the Mother is dead. There is an instance in *Harvy* of a poor Woman, who was found dead in her Chamber; People were much surpriz'd, to see her Child betwixt her Legs. This Child got out of its Prison by its self, as being unwilling to be buried with its Mother: *Harvy de partu, p. 345.*

If some Women are brought to Bed without making any Efforts, or great Endeavours, others again are Deliver'd with pain, yet without any Efforts on the Child's side, as when the Child is dead. The Child doth not always change its situation in the seventh Month, nor doth the Head of it always tend downwards; for, in some Women, the situation of the Child is nothing alter'd, till they are near their Delivery, which they find by their Bellies, which remains not the same Figure, but is bigger, and more extended. It is not the Feet of the Child that breaks the Membranes, but they break or burst of themselves thro' the great quantity of Waters: In short, the Efforts of the Mother do not only proceed from the strong Contraction of the *Matrix*, which closeth, and, as it were, shrinketh it self up, in order to force out the Child; but also from the violent stretching, and Tension of the *Diaphragm* or Midriff, and from the abundance of Blood and Spirits which flow to those Parts to reinforce them.

The Membranes being once torn, or broke, the Waters gush out, and the Head of the Child, which is directly over against the mouth of the *Matrix*, cometh next, bringing with it all the rest of the Body.

D

Here

Here are some Tokens, or Signs, by which one may know when the Child is upon the point of being Born: The *Matrix* bendeth downwards, the mouth of it is loosen'd, for the better opening of it, the Waters begin to appear (I mean one) part of the *Chorion* (which containeth the Waters) advanceth a little into the *Vagina*, or Sheath; the Cavity of the *Basen*, or *Pelvis*, grows bigger, and the Gristle which joineth the *Os Pubis*, often gives way a little. The two lowest Bones of the Huckle bone, or Hip, are turn'd backwards; and hence it is, that young Women are more easily Deliver'd than old; because the Gristle of the *Os Pubis* in them is softer, and more pliable, and the lowest small Bones of their Crupper are not yet ossified, or become perfect Bones, and so upon the least effort they start more backwards, which rendreth the Passage larger.

Harvy de
partu, p.
331.

The natural situation of the Child in the Womb is, to have his Knees against his Belly, and his Legs a-cross each other; his Hands are lifted up towards his Head, one towards the Temple or Ear, and the other on his Cheek. His back-bone is bended down, or crooked, and therefore it hath its Head betwixt the Knees. In fine, the posture of the Child in the Womb, is (in a manner the same we put our selves in, when we go to sleep) the hind-part of the Head of it being always turn'd upwards, and the Face of it towards the *Spina*, or Back-bone of the Mother: But when the time of its Birth draweth nigh, it presently changeth its situation; it bendeth, and flings its Head downwards, as it were to open the door of life. If the Head, in its descent, happens to strike against the Crupper-bone, there it sticks, which occasioneth a difficult and laborious Delivery, and often killeth the Child, and the Mother too.

In fine, all Midwives know, that when a Woman is upon the point of her Delivery, the inward Office of her *Matrix* is always soft, loose and open, for the better passage of the Child, and that it continues always in that state till the Fludding is over, and that all is come away that should come, afterwards it shuts up it self again, and grows harder, in mounting or rising upwards by the contraction of its Fibres. The Child is sometimes born with its Membranes wrapped

wrapped about it; when that happens Women suffer cruelly, by the great Dilatation, or stretching of the Parts. Therefore to prevent this Inconvenience, the Midwife must endeavour to tear the Membranes, that the Waters may flow away, and the Women be more easily deliver'd of the Child. If these Waters flow away before the Orifice is dilated enough for the free Passage of the Child, the Delivery will be difficult and laborious (which is well enough known to Midwives.) These Waters are sometimes in great quantity, sometimes not so much; when there is a great quantity of them, tho' the Child be but small, yet the Women have their Bellies very big.

Tho' we have mention'd the natural situation of the Child in the Womb, we must not therefore imagine that it always keepeth the same situation in all its parts. For being placed in a Liquid body, where it can move it self, as it pleaseth, What is there to press on it, and hinder it? It may stretch forth its little Legs or Hands, extend or bend them; it may turn on one side, and the other. In fine, since we find it sometimes twisted in its own little String or Chord, it is an evident sign, that it moves its parts up and down, according as it hath occasion for it.

Harvy de
partu, p.
331.

As for the Bones of the *Os Pubis* being disjointed, as some pretend, when a Woman is in Labour; this is a vulgar Mistake. We have already said, that the Gristle, which unites them, giveth way a little; for this being a thick Gristle, when it is grown wet by the Humidities which water it, it is rarified, and swelleth like a piece of Leather steep'd in Water. Therefore these two Bones, during the Efforts of the Delivery, may be said to admit of some small distance betwixt them.

Some have amused themselves in disputing, whether the *Matrix* grew thicker or thinner, when a Woman is big with Child; But they who maintain that the *Matrix* grows thinner, by dilating it self, do thereby contradict common Experience; for in the latter Months of their Time, it is always thicker, from the great quantity of Blood which then filleth all its Vessels.

We are to look on the *Matrix* as a kind of Sponge, which swells, and grows very big, by dilating it self;

so that a full *Matrix* differs as much from one that is empty, as a wet Spunge doth from a dry one. The reason or cause why, towards the latter Months, one may divide the *Matrix* into several beds of Fibres, proceeds (as I may so say) from the Rarefaction in the spungy Texture of the *Matrix*. It is, in fine, this Rarefaction, which, by swelling all the Pipes and little Bladders of this part makes it so heavy, That a *Matrix*, which in the first Months weighed but two Ounces, shall weigh in the latter Months more than two Pounds.

Where it is said, That the Blood increaseth in the *Matrix*, or gathereth there in great quantity, it is not to be so understood, as if it Stagnated there without any farther Circulation, for that would create an Obstruction, and that Obstruction a Tumour; but by that Expression we must only imagin, that the Blood doth Circulate more gently in the *Matrix*, which is enough to render it bigger.

Mr. Dre-
lincourt.

We have shew'd that the chief cause which dispos'd the Child to leave the Womb, was, that the Air which he received from the Blood of the Mother, was not sufficient for the Circulating of its Blood in the latter Months; so that he maketh all the endeavours and efforts, he can to obtain a free Respiration, or to breath more at his ease: Yet one of the most able Anatomists of this Age is of a contrary Sentiment. He saith, That the Child, in his Mother's Womb, having never had any Respiration, is no ways capable of Forming any desires on that Account: Nay, he maintains, that to convince any one of this Truth, viz. That the *Fetus* hath no Respiration, 'tis only comparing the Lungs of such Children who dye before they are Born, with the Lungs of those who have liv'd only some Hours after their Birth; assuring us, That those of the first are so Leaden-colour'd, and so charg'd with serosities, that they presently sink like a Stone to the bottom of the Water; whereas the Lungs of the other are of a more Lively colour, and so light, that they presently rise up again to the surface of the Water; by this one may discover the Cruelty and Wickedness of those Leud Debauch'd Sluts, who stifle their Children when they are coming into the World, and who,

who, to save themselves from the Gallows, pretend that the Child was born Dead.

All this makes our Anatomist conclude, that the Child doth not therefore leave the Womb because it wanteth fresh Air, or more of it, but he rather believeth, that it is the abundance of the *Meconium*, (which grows souer, and gives the poor Infant the Gripes and fits of the Cholick) which obliging it to make certain violent motions or starts by these efforts, breaketh the Membranes; and so the water flowing out at this Breach, the *Matrix* cometh very near to the Body of the Child, and increaseth its pains, and so much the more, because in pressing it self together, it giveth the more strokes on the Knees, Feet and Elbows of it, which produces certain irritations in this part, which also, in some degree, facilitate the Birth of the Child. And that if the Child cryeth when it is born, it is, because it is yet troubled with the foresaid Cholick.

Tho' the Abundance, and Acrimony of the *Meconium* may contribute to the Birth of the Child, it doth not therefore follow, that the want of Air is not the first and main Cause; for it is well known, that the Child in the Womb breaths not at all by the Mouth, but rather, as it is in that state all of a piece, or making but one thing with the Mother, all the Breath it hath it receiveth from its own Blood; and if the Lungs of it are then more heavy, than when it hath the benefit of a perfect Respiration, it is because they have no substantial Air in them, and their little Bladder are all sunk down, because they have not as yet been dilated by the Exterieur Air. Therefore it is that the Lungs of a *Fetus* born dead sink to the bottom of the Water, because they are heavier than an equal proportion of it: On the contrary, they will swim on the Surface of the Water, if the *Fetus* hath but once suck'd in the outward Air, because this Air fills up those little Bladders which are never altogether clear of it, as it appears by examining the Lungs of dead Animals, which are always very light.

C H A P. IV.

Of the Principle of Life.

THE Moderns have not without Reason compared our Body to a kind of Machine, since it is composed of so many different Parts, which do the Office of Wheels, Leavers, Chords and Pullies; and what we call Life, consists only in the motion of all these Organs, and Death is only the Cessation of the said Motion. The Life of Man may also be called a Compound, or composed Life, since it consists in the Union of Soul and Body; so that the Motions of the Body give an occasion of Thoughts to the Soul, and the Thoughts of the Soul give an Occasion of Motions to the Body. We shall not here treat of that Compound-kind of Life, which is always buffeted to find out in what the Union of a Spirit and Body consisteth; but we shall endeavour to explain that of Animals, which is purely corporeal.

In short, our whole Body is nothing but a Machine, in which the Soul is not to be considered as a Substance, that is the Efficient Cause of Motion, but only the Occasional Cause, that is to say, that our Soul is not the Immediate Cause of Voluntary Motions, since it serves only to determine them.

The Motions which we observe in Beasts, and which are commonly esteemed as subordinate, or subservient to their Will, are yet only Motions purely Mechanical, which proceed from that Impression which the Objects make on their Organs; for it is this Motion, or Impression of the Objects, which in that great variety guideth the Spirits in the Muscles.

We are already satisfied, that the greatest part of the Motions in us have no dependance at all on the Soul, but proceed only from the Impression of the Objects, and a particular Disposition of the Brain and Nerves; and even those Motions which we think

think are purely voluntary, have no immediate dependence on the Soul, but they also are deriv'd from the Form and Figure of the Part.

For Example, when one would express ones Thoughts by Speech, the Soul is employed in nothing but what it thinks on; It is not the Soul, that dilates or contracts the Breast and Lungs, or that opens and shuts the Lips: In fine, it is not the Soul that moveth the Tongue, or produceth all those Motions which are necessary for the forming of Speech, which Motions are commonly reckon'd among those they call voluntary; so may we say also of other Motions, which we perform for the most part without so much as thinking on them: Thus * one of ^{Mr. Descartes.} the most famous Philosophers of these Times had reason to say, that all kinds of Motions were performed in Men; but that they were not at all performed by Men alone, *viz.* by Thoughts.

We must not be surpris'd at the great variety of all those Motions, (which are in a manner infinite) nor once imagine, that it is impossible they should proceed from a Mechanick Principle, or one that is purely Corporeal; since Art can produce certain Machines, the Motions whereof shall much resemble ours. We have Instance of this in the *Venus of Medallus*, the *Pigeon of Architas of Tarentum*, *Memnon's Birds*, and *Montanus's Eagle*, which shewed the Emperour the way to *Nuremburg*. But not to insist on such remote Instances of this nature, there is to be seen at *Stutgerd*, in the *Hydraulick Cabinets* of the Duke of *Wirtemberg*, the *Statue* of a Man, in which the Motion of the *Chyle*, and the Circulation of the Blood thro' the Veins and Arteries is visibly represented or demonstrated: This wonderful Machine is the work of *Mr. Rosselius*, Physician to Prince *Frederick Charles*, Administrator of *Wirtemberg*.

All the Functions then of a Humane Body are nothing but pure Motions arising from the Spring of that Machine; For if these Functions are nicely viewed, one shall meet with nothing in them but pure Motions. For in effect, what is Eating, The Evacuation, or emptying of our Bodies, Respiration, Circulation, the Motion of our Limbs, &c. ? Nothing else but so many different Motions proceed-

ing from the different Structure, and Conformation of the Organs; whence these Motions are either simple or compos'd.

The Sensitive Soul of Animals is no distinct Substance from their Body; but by this kind of Soul we must understand some corporeal Principle, by which Animals perform all their Motions, to which they are determin'd by the strong Impression which the Objects make on their Senses.

Now this corporeal Principle which constitutes the Soul of Animals is not that gross System of the Parts of their Bodies, which fall under the cognizance of our Senses, but it is a subtle and quick Body, which may be compared to Flame, or rather to Light; because like Light it darts, or spreads it self thro' all the Body.

In fine, this Spirituous Substance is the most subtle, refin'd and active Part of the Blood, and which is commonly call'd the Animal Spirit, which giveth Motion to the Heart, which is the main Spring of the whole Body.

They who have distinguish'd the Principle of Life, and have thought, that it was a Substance purely distinct from Matter which they call'd Natural Heat, Fiery Substance, Vital Spirit, *Archons* &c. have been deceived; For this Principle of Life consisteth only in a certain Motion, or a certain Modification of the Blood, which giveth it that Heat and Fluidity.

Life depends on two Motions; on the inward Motion of the Blood, that is to say, of the Motion of all the small Particles of it, and of its Circular Motion. The latter is sensibly perceiv'd. As for that inward Motion, it is not, nor cannot be at all perceived by the Senses; yet the many different ways by which it is filtrated, plainly shew that Blood consists of many various Particles, and those endued with different degrees of Weight and Motion.

This Intestine, or inward Motion of the Blood depends not on its Fermentation; for the Blood is no more capable of Fermenting of it self than Wine is, but it hath this Motion from the subtle Parts of the Air, which mix themselves with the Blood, and penetrate into all the small Particles of it.

The

The Blood doth not only enliven, and quicken the
by its Heat, but it communicates to them a
rain Motion; even as Water being injected into
Arteries (by a Syring) of a dead Body, exciteth a
tion in the Muscles, by making them shake or
mble.

As for the Heat of the Blood which some derive
m the Fermentation of it, it is a certain Motion
ich is raised in the Blood by the Air we breath,
suck in; in the same manner as it is raised in the
ood of Fishes by the Water which surrounds them.
they say, that the Heat of the Blood proceedeth
m certain Salts and Sulphurs fermenting together,
ask, how comes the Blood of Fishes which is so
phurous, to be so cold? The Heat of the Blood
Animals, and the Coldness of the Blood of Fishes,
ither of them, then depend on the Fermentation,
or of the swiftness, or slowness of its Motion, since
th, which are so cold, are yet very swift, and con-
sequently their Humours are in a great Agitation.

CHAP. V.

Of Respiration, or Breathing.

THE chief cause of the Motion of the Blood, and
of all the Animal Functions is the Air, which
asseth into the Lungs as we breath, now of all these
functions, none is more sensible, or more necessary
than Respiration, which one cannot any ways want,
without incurring evident danger of ones Life.

Some have said, that the Suffocation which hap- Galen, and
all his Fol-
lows.
pen'd when the passage of the Air was any thing ob-
structed, proceeded from those Fuliginous Vapours,
which having no Vent, extinguish'd the natural
Heat; just as the Fire is smother'd, and put out,
when the Smoak hath no passage for it. But this
is a superannuated Error which is laid aside long a-
go;

go; for since there is no such thing as Fire in Heart or Blood, it is impossible that any Smoak (that of Fire) should arise from thence, and all Heat which is in the Heart, and in the Blood only a soft gentle Heat, incapable of making Smoak.

Tho' the Heat of the Blood doth in some degree resemble the Heat of the Fire, yet the Fire is not extinguish'd in a close place, as it is commonly said. For we see by Experience, that a lighted Candle and Coals which burn without much Smoak, do not out so soon in a place that is full of Air, as in a Place where there is none at all; methinks, it is Reason which is alledg'd for solving of this Phenomenon, were true, or solid, it would happen quite contrary; that is to say, that the Fire would rather keep in, in a place that was void of all Air, because the Smoak would then have room enough to spread it self. By the same reason also Animals would live in a Machine where there is no Air, because the Fuliginous Vapours of the Lungs would then have room enough to dilate themselves; but we find the contrary, by common and daily Experience.

All these Reasons then sufficiently teach us that the Air serveth not to cool the Blood as some pretend so we must find out some other use for respiration. Thus you have it explain'd; the Air which Surroundeth our Bodies, absorbeth those watry Vapours which are expell'd by Expiration into its own pores so that the Air taketh them with it, and carryeth them off as a fierce impetuous Wind doth the Humidity or Moisture of any other Body. But in order to effect this, it is necessary, That the consistence of the Air should be something proportion'd to our Respiration; for when it is too much Condensed it is altogether incapable of receiving those Seropities of the Blood, which are rarified into Vapours. This we find in Mines and other Subterraneous places, when the Air is so thick and cramb'd with Vapours, that it can receive no more; therefore the Air which one sucks in, or breatheth there, stiles or suffocates one, just as if one were fallen into the Water: Besides that, the Air serves also to keep the Blood

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in a certain state or motion of Liquidness, by thickening or coagulating it with its Nitre, we falsely suppose; for were that true, death inevitably follow.

They who will have it, that the Air we breath in supporteth and keepeth life in us, by supplying us with fresh matter for the Spirits, have as little reason on their sides, as the others; how can they imagine so small a time, in which the Air is intercepted, should so soon occasion the Death of any Animal, living Creature? If there is no other use for Air, than to furnish matter for the Spirits, and that those Spirits are at every moment spent and dissipated, how possible they should be so soon repaired by the Air we take in?

There are some who pretend that all the use of Respiration consists in making the Blood Circulate: They consider the Lungs as a kind of a Press, which squeezeth the Blood together, in order to make it pass into the left Ventricle of the Heart. tho' the Lungs do much contribute to the Circulation of the Blood, (because of the Air which filleth up their little Bladders, and by its spring presseth together all the little Vessels there) yet the other Vessels have also their share in promoting this said Circulation; because their repeated and alternative Contractions drive on that Liquor, and preserve in it its fluidness, which the Air, by its secret Spring, communicates to it on every moment. Besides the Blood of the Child in the Womb Circulates also, as well as that which rowleth in the Veins of other Men advanc'd in Years, tho' the Lungs there have no Action at all.

They who believe the Air is full of a Spirit of sulphurous Nitre, that supports or keeps up Life by continued Respiration, do (as we may so say) walk in the Air, and without any solid grounds, when they pretend to prove this their Hypothesis about Nitre, by the instance of several Plants which spring up and bud out in the Air, as the Sea-Onyon, and other bulbous Plants; as also by the Instance of Serpents and Spiders, which can live a long time on Air only. They should reflect, that the Vegetation of these Plants proceedeth not from their pretended Nitre, but

but from the Vapours which are scattered in the
and in the Earth, it is Water only that makes
Plants grow. As to *Spiders* and other Insects if
live a long time when they are shut up in a
Vessel, without Eating any thing, it is because
Vapours of the Air are sufficient to keep up the
Nourishing Juice. This also is to be said, that the
Animals being in a manner no ways spent or worn
they want no other Nourishment or Food.

In fine, tho' there was *Nitre* in the Air, as there
in effect, these Saline and Sulphureous particles would
never be able to penetrate the Blood, because they
are too gross; for as to Air, none but the most fine
and loosest parts of it can penetrate or pass with
the subtle matter into the Blood, by communicating
to it that intestine or inward motion, which produces
the heat of it. As to the manner how Respiration
is perform'd, you must know, that all the motion of the
Lungs have proceeds from the Air, which is forced
there by the motion of the Breast in dilating it.
For this motion of theirs ariseth not from any natural
faculty in them, that draweth the Air to refresh
the Blood but the first principle of this motion is derived
from the Muscles of the Breast, that is, to
speak more clearly, the Lungs are not therefore
filled with Air, because they are dilated, (for the
Lungs have no Action in the work of Respiration
but they are therefore dilated, because they are filled
with Air.

There are a thousand Experiments to convince
that the Lungs have no Action of themselves, and
all their Action is derived from the Spring of the
Air which enters into the little Bladders of it, when
the Breast is dilated: For when the Breast hath two
Holes on the sides of it, the Motion of the Lungs
entirely ceaseth; because no Air entring in at the
mouth, that which rusheth in at the two Holes, when
the Breast lifteth up its self, presseth the Lungs together
with that force, that they cannot dilate themselves.

It is true, that every time the Breast dilates or contracts
it self, the Lungs do in a manner humour, and comply
with this Motion in rising up and falling down
but we must not therefore conclude, that they move

themselves, since the Breast is the cause of this
 motion; for when the Ribs rise up, the Lungs must
 retire inwards, because the Air which enters
 fill at once, beateth them back: On the other
 when the Ribs are contracted, the Lungs press
 hardly into the hole of the Wound, as one may
 see, because they are pressed by the sides of the
 Chest. Some have pretended, that the Lungs have a Motion of
 their own, and that they dilate, or contract
 themselves, by means of the moving Fibres which
 are in their little Cavities or Cells, but they are de-
 termined in this Point; the Lungs are not to be look'd
 upon as the efficient Cause of this motion, for nothing
 but the motion of the Breast determineth the Air
 to enter into the Lungs, as it hath been said be-

Willis.

Fibræ Motrices.

Inspiration, or the letting in of Air, the Breast
 dilated, by letting it out, it is contracted by the
 reciprocal motion of the Ribs and *Diaphragma*; so
 in breathing, or the taking in of Air, the Ribs
 move to some distance from each other, and rise up-
 wards: and in Expiration, they come close to each
 other, and fall downwards.

We may ask whence it is, that the Air entereth into
 the Lungs, whether it be from an Abhorrence of a
 vacuum, or because all is full? To which we re-
 spond, that it cometh neither from the one, or the o-
 ther; but that it is as purely from its one weight,

Boyle.
Borelli.

and Elastic Faculty.
 There are two kinds of Expiration, one Moderate
 and Natural, and the other Violent. The first re-
 quires nothing but the spring of the Ribs, which re-
 turns them to their natural situation, and the relaxation of
 the *Diaphragma*, which riseth again into the Breast;
 in a violent Expiration, as in those who Sing or
 Strain, the Motion of the Muscles of the Belly, the
 Contraction of the triangular Muscle, and that of the Ster-
 num, or Breast-bone, are all necessarily required to
 drive the Air from the Lungs swiftly; to which also
 must be added, the Action of the Muscular Fibres be-
 longing to the little Bladders.

All that hath been said here, it appeareth that
 the Business of Expiration consists in driving out the
 Air

Air that is got into the Lungs, that still fresh Air succeed in the room of it, to keep up the Motion the Blood by vertue of its spring, and convey it to all the capillary Pipes of the Body, as it is by one driveth the Air into the Hydraulick Machine for they make certain Liquors run thro' the Capillary Pipes, without which they would not be able to penetrate them.

CHAP. VI.

Of the Circulation of the Blood.

HAVING already Treated of the Motion of the Particles of the Blood, we must now explain another Motion, by which the whole Mass of Blood is carried from the Heart to the Extremities, or remotest parts of the Body, and from thence to the Heart again, and this is what is commonly call'd *the Circulation of the Blood*. Nothing is more certain than that the Blood, after it hath visited all the parts of the Body, returns again to its Fountain the Heart. This is so certain a Truth, that no one doubts of it. Experience demonstrateth it, the Ancients and Moderns do both unanimously assert it: They all agree that the Blood moves, and if there be any Difference or Dispute betwixt them, it is only about the manner of that Motion.

The First of them, *viz.* The Ancients supposed there were two sorts of Blood, that which was contain'd in the Veins, and that which was contain'd in the Arteries: They said, that the Blood of the Veins proceeded from the *Chyle* which the Mesenterick Veins suck'd up, the grosser part of which *Chyle* was directly conveyed to the Spleen by the *Ramus Splenicus*, while the more subtle part of it was transmitted to the Liver, in order to be changed into Blood by these *Viscera*, and that the Blood of the Liver was carried as well by the *V. Cava Ascendens*, as by the *Descendens*, to serve as Nourishments for the Parts.

Thos

se Parts being yet excepted, which were appointed for Digestion, because they were nourished by grosser Blood of the *Ramus Splenicus*, and that the Blood of the *V. Cava Ascendens*, went to the Superior Extremities, as the Head; but that part of it immediately directed its Course into the right Ventricle of the Heart, and from thence passed into the left, cross the Lungs, and that partition also which divides the Ventricles of the Heart: That this portion of Blood being filled with that Vital Spirit, which is contained in the left Ventricle, from thence distributed thro' all the Arteries; so, that according to the Opinion of the Antients, the Blood of Arteries and Veins always moved from the middle, Center of the Body, to the Extremities, without returning from thence.

Thus you have the Opinion of the Antients, about Motion of the Blood, laid down here in few words.

There hath also been propos'd another Opinion, about the Motion of the Blood, which seemeth parallel enough. By this it is suppos'd, that the four principal Vessels which are terminated at the Heart, do not only contribute to the Motion of the Blood, but every one of these Vessels hath two contrary Actions at the same time: As for Example, that the *Arteria Venosa*, letteth the Air into the Left Ventricle, and at the same time giveth a passage to the Vital Spirit from the same Ventricle into the Lungs, in order to vivifie, or quicken them: That the *Vena Arteriosa* also giveth a passage to the Air from the Lungs into the right Ventricle, and at the same time a passage to the Blood of the Veins which passeth from the same Ventricle into the Lungs by a contrary Motion: That the *Vena Cava* carrieth two kinds of Blood, an imperfect Blood, which is brought to perfection in the right Ventricle, and a perfect Blood, which is that which was perfected in that Ventricle, and returns into the *Vena Cava* by a contrary Motion: That, which always is directed to the Right Ventricle. That the *Aorta* affordeth a passage for an imperfect kind of Blood into the Left Ventricle, and a passage for a more perfect and spirituous Blood out of the same Ventricle, which is afterwards distributed

Varolus
L. 2. of his
Anat. Ch. 1.

buted thro' the whole Body, as the Blood of Veins is.

Licetus.

This is the Discovery which another pretends have first invented; Tho' we cannot but justly ascribe it to the former, for the last proposeth a double Circulation, and that also not in the same Vessels, but in the Veins and Arteries successively, and at several Times.

Harvy.

These two Opinions, as well as the former before mention'd, are all of them contrary, and inconsistent with the Circulation that hath been happily discovered in these our Days, which is certainly the most useful, and most important Discovery in the whole Body of Physick, and will immortalize the Author of it.

The Motion of the Blood is not therefore call'd Circulation, as if it made a true Circle, for that is impossible; but because the Blood having once begun to move it self from the Heart to the Extremities by the Arteries; it returns again to the Heart from the Extremities by the Veins continuing the Motion, without any intermission, as long as the Animal liveth: Thus taking the Circulation of the Blood for a certain Liquor that returns to the place where it first began its Motion, in the same Sense as Rain, and the Water in the Rivers may be said to Circulate also; because Rain, after it hath fallen on the Earth, is rarified, or turned into Vapours by the Heat of the Sun, in order to fall down on the Earth again, in drops of Water, and the Water in Fountains, and Rivers runneth continually towards the Sea, which always bringeth back, as much of it towards the Feet of the Mountains, as flowed at first from the Tops of them, whence it cometh to pass that the Sea never encreaseth, notwithstanding so many Rivers are emptied into it, because it constantly sends back, as much as it receiveth.

The cause of this Local Motion is not in the Blood, which (as all other Liquors do) depends on some outward Cause for its Motion. Now nothing but the Heart can determine the Blood to move it self, for that being a strong Muscle, whose Contractions are very vigorous, it forceth the Blood to the Extremities of the Body, from whence

hence it afterwards returns to Circulate as be-

The Heart then is the Machine, which maketh the Blood to Circulate, it being as it were a kind of Pump, which pusheth the Liquor thro' the whole Body, and giveth it this Circulating Motion, for the Blood cannot be driven into the Arteries alone, without passing also into the Veins, in order to return to the Heart, because these Vessels are all full of Blood, and that there are certain Communications from one to the other, not by an Anastomosis as we shall shew. When we speak of the Circulation of the Blood, we must not imagine, that nothing Circulates but that, for the *Chyle* and the *Lympha* must needs Circulate together, and wherever there are any other Vessels, there are also those we call Lymphatick Vessels; and the Ancients also have said, that the Serosity was the Vehicle of the Blood. As for the *Chyle* it Circulates also with the Blood, yet not at all times as the *Lympha* doth, because it cannot incorporate it self with the Blood till the digestion is over, and that it begins to be distributed. If you breath a Vein at that time, you may perceive a whitish Liquor swimming on the Blood, which is only *Chyle*, and seemeth to be serous, because there is much *Lympha* mixed with it. Thus we see that the *Vasa Lactea*, and the *Lymphaticks* are to be placed in the number of those Vessels, which contribute to the Circulation of the Blood; These last differ not at all from the Veins, since they serve to bring back that *Lympha* from the Extremities, which the Extremities had received from the Arteries.

It is certainly the Heart then, which pusheth the whole Mass of Blood into the Arteries, for it is evident, that the Circulation lasteth as long as the Heart continueth its motions, whereas as soon as ever the Heart ceaseth to act or move, there is no farther Circulation; which gave occasion to that saying, that the Heart was the first Part in the Body that began to live, and the last that died, to shew us, that the Animal then presently began to live, as soon as the Heart by its continual beatings, was in a Condition to make the Blood Circulate, and that it

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immediately dy'd upon the ceasing of those motions of the Heart.

The Heart hath two Motions, as one may observe in a Living Dog: The first is when the *Cone* of it approacheth the *Basis*, and that it is contracted on all sides, according to the direction of *Fibres*, and this Motion is commonly called *Systole*. The other is, when upon the relaxation of the *Fibres* of the Heart, the *Cone* of it withdraws it self from the *Basis*, and this Motion is called *Diastole*.

So that upon every *Systole* that happens, the Heart must needs force out all the Blood that is contained in its Ventracles: on the other side in a *Diastole* the Heart filleth it self again with Blood, which may easily observ'd in the Heart of a Frog, which in *Systole* groweth pale and whitish, because the Blood then leaveth the Heart, and in a *Diastole* it becometh Red again, upon the return of the Blood to the Heart.

The *Diastole*, is nothing else, but a motion of restitution, that is to say, a motion by which the *Fibres* of the Heart return to their first and natural state, or position: The *Systole* also is nothing but a certain Tension of its *Fibres*, or rather a Contraction on which shuts up the Ventracles, and presseth the Blood on all sides with that force, that the Blood must necessarily be squeezed from it, as from a Press.

When one considereth the structure of the Heart and vieweth well the Order and Disposition of its *Fibres*, one is apt to believe, that it is a true Muscle that acts only like other Muscles: (Were we wholly taken up in unfolding this structure, and shewing how these *Fibres* run from the *Cone* to the *Basis*, and back again from the *Basis* to the *Cone*) we should have a particular Satisfaction to say something on this subject; but since none, as yet, hath ever Handled this Point, more judiciously and more accurately than those three famous Anatomists and Philosophers of this Age, we may see what they have said of it; For after them there is scarce anything more to be said on that Subject, we shall then observe by the way, that *Vesalius*, after he had said, that the Heart was a Muscle whose *Fibres*

Steno,
Lower
Borelli.

particular structure, doth yet assure us, that it is impossible to unravel or unfold them, and to demonstrate their Order, Course or direction. Let the experiment be made on it, either when it is boyled, or when it is raw, or not boyled. But notwithstanding any thing he can say on this Point, by the instructions which *Lower* hath left on this Subject, and the smallest pains imaginable. the Heart may be easily prepar'd, yet not by boiling it as some do; because in so doing, the *Fibres* break, and there is no unfolding of them afterwards. It is better then to let it steep a while in Luke warm-water, that by the gentle motion thereof, the *Fibres* may loosen themselves, and be divided by little and little from each other. Afterwards one may steep it in Vinegar.

The Heart holdeth a Communication with all the other Parts of the Body, by means of the four great Vessels, whose names, structure and distribution are so well known, to amuse our selves with the Description of them here. We shall only observe then that the Blood which enters into the Heart by the *Vena Cava*, and the *Vena Pulmonaris*, or Vein of the Lungs, is not carried there immediately, or in a direct course, but is something directed, and tarrieth a while in the Cavities of the little Ears of the Heart, before it passeth into the Ventricles thereof.

The little Ears are two small Muscles, fasten'd to the *Basis* of the Heart, which by their Contraction, serve to drive the Blood into the Ventricles; for during the *Dyaſtole* of the Heart, they are contracted, that is to say, they drive out the Blood thence, as soon as ever the Heart is dilated, in order to receive it; and they are presently full again, as soon as the Heart contracts its self, for driving it into the Arteries. Those Fish which have but one Ventricle in their Heart, have also but one little Ear: Besides the Motion of the Heart always begins at the little Ears, as one may observe by an Animal that is dead, and already cold. For in syringing in of Water, or in blowing only into the *Vena Cava*, one seeth that the right little Ear beginneth first to move; and then the Ventricles begin to beat, and upon this Motion immediately succeeds that of the little Ear on the left

side. The same thing is observed also in Animals which are ready to expire. The beating of the two little Ears always preceeds that of the Heart, and even after the Motion of the Heart hath entirely ceased, they still continue their Motion for some moments, but especially that on the right side, which hath a kind of Palpitation, a long time after the Heart hath left of moving.

Borello: There is a Modern Author, who believeth, that these little Ears do hinder the Blood which is once got into the Ventricles from returning again into the Veins, because they shut, or contract themselves very closely, after the Blood is passed into the Ventricles. But this great Man is certainly much out, or deceived, he hath altogether forgot his own Hypothesis. For since the *Systole* of the little Ears precedeth the Contraction of the Ventricles, when the Ventricles are dilated, nothing can enter into the Veins; on the other side the Blood of the *Vena Cava*, and that of the *Vena Pulmonaris* passeth into the Ventricles, upon the Contraction of the little Ears. Moreover, their being dilated, would hinder any Blood from returning into the Veins during the *Systole* of the Heart, because the *Valvules* stop the passage of it, and are open again, as soon as the Blood is driven from the Ventricles, because then the little Ears are contracted.

Higmore.

He who looks on the two little Ears as certain Cavities appointed to divert the Blood a while in its Course, hath hit better on it; he saith, the Blood of the Veins is carried thither, in order to continue there some small time; for if the Blood of the Veins went directly to the *Ventricles* of the Heart, two great Inconveniences would thence follow. The precipitate Course of it would presently hinder the *Ventricles* from coming near one another, that is to say, that the Blood by rushing in with that Violence and Force, would hinder the motion of the Heart. The other Inconvenience which would follow, is, that the *Valvules* would never be able to shut themselves from the constant flowing of the Blood there. But Nature hath so well ordered matters here, that the Blood enters not into the Heart all at once, but at several times, and by

y degrees, according as it is dilated ; for as it hath
 been observ'd, as soon as it is dilated, the Blood of
 the little Ears is driven out by their being contracted
 to the *Ventricles* ; so that in some Sense we may
 say, they are the measure of the Blood, and shew
 how much of it enters into the Heart at once.

As the Trunks of the *V. Cava*, and right *Ventricle*,
 are much bigger than those of the *Vena Pulmonaris*, and
 the left *Ventricle*, so also the little Ear or *Auricle* on the
 right side is much bigger than that on the left ; but
 that which is here to be observ'd, is, that wonderful
 Artifice Nature hath made use of, or contriv'd ; That
 the Blood which descendeth from the *V. Cava* may
 not check or oppose that which ascendeth. There
 is at the Mouth of the *V. Cava*, where it begins to be
 divided into two Branches, a little knob rising up a
 little above it, which is firm, solid, and in a manner *Carti-*
laginous.

This little Partition directs the Blood that de-
 scends into the left *Ventricle*, in that manner, that the
 Blood which returneth upwards is not at all ob-
 structed in its Course : This knob is higher in Man,
 because of the erect or straight posture of his Body ;
 and in other Animals, whose Bodies run parallel to
 the Horizon, it is lesser, and cometh not out so
 much. On the outside, there where the knob is
 plac'd, the *V. Cava* is more Musculous, it receiveth
 some fleshy *Fibres* from the little Ear ; therefore by
 its contraction it drives the Blood upwards with so
 much Force, that the Blood which descends, can
 never ways hinder its passing into the right little

Ear. In fine, to prevent the Blood that is passed into
 the *Ventricles* of the Heart, from returning into the
 Veins during the *Systole* ; there are at the Orifice of
 the *V. Cava* and the *V. Pulmonaris*, certain small Mem-
 branes, which are so fastned to these said Orifices,
 that as soon as the Heart contracts its self, they join
 together by a reciprocal relaxation, in order to
 close or shut up the said Orifices ; whereas, when
 the Heart is dilated, they open towards the Heart,
 and are dilated or widen'd by the Blood which is
 driven there, upon the contraction of the little Ear,
 at the same time the Points or Ends of them be-

ing fastned to the fleshy Substance there, they are drawn inwardly, at that time when the Heart is loosened or relax'd: Thus the Action of these small *Valvules*, which serve to close the Orifice of the *Veins*, doth partly depend on the relaxation of their *Fibres*, when the Heart is contracted, and partly on the effort which the Blood makes to get out of the *Ventricles*, which raiseth and pusheth them directly against the Orifice, with that violence, that not being able to return towards the little Ears, it must necessarily pass into the *Arteries*.

This strong impulsion of the Blood proceeds from the Contraction of the Heart, which is effected by the shortening of its Spiral *Fibres*, and as they are swelled by the Spirits, with which they are filled, they take up all the space of the *Ventricle*, and the Blood which is there is forc'd to give way and go thence. *Harvey* then had great reason to define the motion of the Heart thus, *viz.* That it was a Tension and a Contraction of all its *Fibres*, which happens according to their direction. If any one yet doubteth whether the Heart is contracted in a *Sole*, they may be assur'd of it by a very easy Experiment. Open any living Creature, make an incision in the Heart big enough to put in the end of your Finger, when it beareth, and you may perceive, that the Finger is shut in, because the *Fibres* being joined near each other, and being swell'd, press it together.

Mr. Des-
Carte's
in his Treatise
of Men,
and his Methods.

Having now seen and prov'd that the Heart is a Muscle, we must now endeavour to find out the cause of its Motion. We shall not say with *Galen* that there is in the Heart a certain *Vital* and *Passive* faculty, or that this motion is derived from a fermenting of the Blood in the *Ventricles*, as a most famous Philosopher pretends; but we shall shew that it dependeth on the Course of the Spirits, which pass from the *Nerves* into the *Fibres*; which obliges them to contract themselves in being swelled, as happens to the *Fibres* of the other Muscles. First, even when the course of the Spirits, thro' the *Nerves* to the Heart, is any ways interrupted, the motion of the Heart is certainly stopp'd: This is what we observe when we make a Ligature in the *Nerve* of the eighth

er, for the motion of the Heart presently ceaseth
it, as doth also Respiration. 2dly, the Heart, af-
it is taken out of the body of a Living Animal,
areth still for some Moments; and if you prick it,
er it has lost all its motion, it begins to renew its
orions a fresh; which proceedeth purely from
se Spirits which are still remaining in its *Fibres*,
ich may easily recover their motion when one
aketh them. But to shew you, that there needeth
a much force to make the Heart move, you must
ow that a little Breath only, or a few drops of
arm Water pour'd on it, will do it; which is not
be imputed to the Spirits alone, which remain in
e *Fibres* of the Heart; but also in some degree to
e structure of their *Fibres*, which consisting of a
m and solid Substance, and being also of a spiral
orm or Figure, may easily tremble when they are
uch'd.

Thus it is for Example, That the Blood of the
Ventricle on its part contributes to keep up the mo-
on of the Heart; not that there is any leaven in
Ventricle to make it ferment; but because the Blood
annot enter into the Heart, without touching on
Fibres, and consequently making of them shake;
that the Spring of the Spirits obligeth them to
ontract themselves; which is explained more at
rge, where we treat of the motion of the Mus-
es.

Besides the Blood of the *Ventricles*, which, as we
ay so say, serves as a Goade to prick forward, and
romote the motion of the Heart; there is also the
lood of the *Coronary Arteries*, which being Pump'd
ith great force into the *Arteries*, sheds it self into all
e substance of the Heart; so that this motion,
in'd with that of the Spirits, are two great Causes
f the contraction of this Muscle.

The Blood being driven from the *Ventricles* of the
Heart by this kind of *Vibration*, darts it self into the
Aorta, and the *Arteria Pulmonaris*, and is afterwards
arried thence into all the other parts of the Body,
y the Branches or ramifications of this *Arterie*. Thus
he Pulse or beating, which is sensibly felt at the
Wrists, the Temples and other *Arteries*, proceeds
om the force or strong impulsion, by which the

Blood is driven from the *Ventricles*, for being forc'd from the *Ventricles* with great violence, it is impossible that it should pass into the *Arteries*, without dilating them, because it beateth so strongly on the sides of them.

But the *Arteries*, besides their being dilated or widen'd by the Impulsion of the Blood against the sides of them, are also furnish'd with a Spring from their Musculary *Fibres*; and as they make some resistance to this Impulse, they must needs afterwards be contracted, by which contraction, the Blood is squeez'd even into the smallest little Bladder of the Parts. We see also, that the *Valvules* (call'd *Sigmoïdes*) which are at the Mouth of the *Arteries*, must needs hinder the Blood from returning into the *Ventricles*, the *Arteries* being once contracted.

The Capillary Branches of the *Arteries*, which lose themselves within the substance of the Parts, have no such hard and *Nervous Membrane* to keep up the impulse of the Blood by its Spring; yet, on the other side they are very fine, and their Orifices are so proportion'd to the pores of the *Fibres*, that the Blood may have an easy Passage there, and Sweat thro like a dew, for the nourishing of the parts.

All those Particles of the Blood, which are not yet proportion'd to these Moulds, are beaten off by others, and return into the little Branches of the *Veins*, or *Lymphatick Vessels*, and from these they pass into others which are larger, and so on till they come to the *V. Cava* and the *V. Pulmonaris*, which discharges them into the little Ears of the Heart from whence they pass into the *Ventricle* thereof.

The Blood is not drawn again into the *Veins* by any kind of Attraction, but there is some particular Cause which forceth the Blood back again into the *Vessels*, and that is, the continual flowing of the Blood there from the *Arteries*; for we see, that upon every stroak or beating of the *Arteries*, the Trunk of the *V. Cava* is filled.

The *Peristaltick* motion of the *Veins* doth also contribute in a great degree, to the return of the Blood from the Extremities to the Heart; for since it must pass from a small Channel still into a larger, it would

lose that impulse it receiv'd from the *Arteries*, there not some elastick Force or Spring in the *sculous* Membrane of the Veins, to direct or determine its motion towards the Heart; and this is reason, why the *Vena Cava*, and other Vessels, have a more sensible motion near the Basis of the Heart; to this end, that the Blood may not stop at there, when it returns to that Pump; we must also mention the effect of the *Valvules*, for by opening themselves one after another, like so many doors, they no wise obstruct the Course of the Blood, which would infallibly stagnat, were those Valves once shut up, as it happens in those who are Varicous. In fine, if to all these Causes, we add the natural Spring of the *Fibres*, we shall easily comprehend how the Blood passeth into the Veins, and how free and easily it moveth there.

Some have asserted, That there was no difficulty to explain the manner of the Bloods passing from the *Arteries* into the Veins, since there was a reciprocal anastomasis betwixt them; but these Communications of the *Arteries* with the Veins, in no ways suit with common reason; and this is not yet discovered to be true, and tho' we should suppose with the Antients that it was so, it would be impossible for the Blood to be dispers'd into all the void spaces of the Parts, in order to penetrate the Substance. Besides the Blood must needs thus continue its Course strait on, without penetrating the Texture of those small Vessels, belonging to the Parts of the Body. For the Liquor, which can continue its motion thus, thro' large, strait and open ways, will of its self seek for those which are narrower and more winding: Thus, according to this old Hypothesis, there would be no separation of Humours, nor any filtrating of them in the *Glandules*, since the Blood would immediately pass from the *Arteries* to the Veins.

These Reasons are back'd with two undeniable Experiments. 1st. If one maketh an Injection of warm Water into an *Arterie* on the Arm of a Dead Body, and then make a Ligature on the Vein that goeth along with it, prick this Vein below the Ligature, and you shall see that no Liquor or Water shall flow out thence, till it hath first filled all the Arm and

and Hand. 2dly. Syringe some Red, or what Wax you please, into an *Artery*, and make an Injection of something of another Colour into the Vein, that is over against the said *Artery*, you will have the satisfaction to see all the Capillary Branches, and the substance of the Part penetrated by the Wax; but you will not see these two Injections mingled with each other, or that the Wax is confounded in pressing thro' any secret Channel, which is equally common to the *Arteries*, and to the *Vedue*.

These two Experiments evidently shew there is no Anastomosis at all betwixt the Arteries and Veins, and one seeth at the same time, that the Blood in coming out from the Arteries spreads it self all about the spongy Texture of the Parts, from whence it is presently caught up by the Veins which carry it back again to the Heart.

One may easily conceive the use of the Blood in the Arteries, from what we have said: That which for example goeth to the Kidnies, besides the nourishing of them, it there dischargeth it self of its Serosity: That which is carried to the Brain to the Liver, or to the Testicles, &c. furnisheth Matter for several Liquors which are useful for the whole Body. In fine, the Blood is exalted and perfected in passing thro' the Lungs; it deposeth its Lymph in the Glandules, and communicates a Heat to all the Parts it watereth, and giveth them that vital Motion which is perceived in them. Whence these Parts which are once deprived of Blood wither, and dye away like Trees that lose their Sap. As for the Blood of the Veins, the only use of it, is to preserve the Heat of those Parts thro' which it passeth. Besides one may easily see, that the Circulation of the Blood keeps it always fluid, and that without this Motion, it would either turn to a Serosity, or entirely curdle, or coagulate.

Before we put an end to this Subject, we shall examine two Things: Whether the Heart be the Seat of the Passions, and whether there be in it any Fire without Light, for the keeping in, or supporting the Life of Animals. They who maintain, that the Passions are most sensible in the Heart say, that it is the place where the Soul feeleth all those Motions which

ch happen to us. To this we answer, that if Passions are most sensible in the Heart, this proceeds from the Cardiac Nerves, as pain is felt in the Foot by the Nerves of that part; and even as we perceive the Stars in the Heaven by the Help of Light and the Optick Nerve: So that it is no more necessary that the Soul should reside in the Heart, to render it sensible of the Passions which are there, than it is necessary it should be in the Heavens to see the Stars:

As to the Fire which some have placed in the Heart, some have thought it a Fire without Light: Others again have asserted, there was nothing more luminous than this Vital Fire, in the mean while, no one as yet, hath perceived this pretended Chimerical Fire, besides the Blood, which is like warm Water, would sooner extinguish it, or put it out, than kindle it. But suppose there was a Fire which burn'd continually in the Hearts of Animals, and which communicated to the Blood all its Heat, by making it ferment, why do we not see, or perceive this Flame, when we pull out the Heart of any Creature? At least it should appear in the dark like that of the *Phosphorus*. They will say it is a Fire without Light, but it is not to be seen, or met with: For if there was any true Fire in the Heart, how ever so little, it would consume it at last. Perhaps they who are of this Opinion will also say, that this Fire which causeth the Heat of the Heart is derived from an Effervescency of the Blood in the Ventricles, occasioned by a certain Leaven which is there; but this is a bare Supposition without any Proof. If they say it is natural, and that it is either in the very substance of the Heart, or in its Ventricles, we answer, that a Muscle as the Heart is, is not capable of forming any Leaven. Besides, were it true that there was any Ferment in the Heart, could it possibly boil the Blood to that degree, as to render it frothy. This is contrary to Experience, which sheweth, that the Blood which cometh from the left Ventricle, is no ways different from that which the Left little Ear poureth into it; It is true that the Blood, when it cometh from the left Ventricle, seemeth frothy, but the reason of it is evident, since

Descartes.
Hogelandes.
Helmont
Horstius
Barthoelines.

it cometh from the Lungs, where it is certainly mixed with much Air.

Sylvius
de la Bo.

A Learned Physician explains this Matter after particular manner: He pretends that the Fermentation of the Blood in the Ventricles of the Heart proceedeth from the Acid *Lympha's*, being mixed with the *Alkeline* Salt of the *Bile*. But there are two Things in this Hypothesis which we cannot allow of. First, That he maketh the *Bile* pass from its own Bladder thro' the *Porus Hepaticus*, in order to mix it self with the Blood. Secondly, He maintains, that the *Lympha* is acid in its natural state, which is contrary to all Experience. We shall hereafter examine the Motion of the *Bile*, and we shall shew whether the *Lympha* is truly Acid, as also most of the Moderns will have it to be.

CH A P. VII,

Of Nourishment,

THERE are two Uses for Nourishment, the first and the chiefest is to keep up, and preserve Life: The other is for the growing and augmenting of the Parts of the Body: For the Blood being a fluid which is in constant motion, some parts of it are spent, and dissipated every moment, and therefore a Supply of fresh Particles is absolutely necessary to make Reparation for those that are lost or gone:

The solid Parts, as the Bones, Gristles, Tendons lose not so much of their Substance, as the other soft Parts, and we may be assur'd, that the Bones scarce lose any thing of their substance or bulk, for in all those Creatures which have died of Hunger and who have subsisted a long time with a very small Nourishment only, their Bones seem always of the same bigness. It is not so with the Muscles, Membranes, and other Bowels; since as all these Parts are made up of many little Bladders which are in a manner

er swelled and extended, with the nourishing
 so soon as the Juice which was contain'd in
 is exhausted and spent, they fall flat down on
 other, and grow flabby and loose: Therefore
 that the Flesh keeps not up its bulk as the
 do, which are of a harder Substance, whose
 Cells, or Cavities and Conduits always retain in
 same Figure and bigness, tho' there remaineth in
 no more nourishing Juice.

ne may distinctly observe two kinds of Nourish-
 : The first is, what is presently taken, even
 in the Parts are not perfectly manifested or un-
 ed; the other happens after all the Parts have
 ined their just proportion and bigness, and are
 sed to be extended only. In our Youthful Time,
 whilst we are yet Children. all the Parts of our
 es are tender and soft; and as they are only a
 p of Pipes and little Bladders not arriv'd yet to
 just length or extension: Food or Nourishment,
 may so say, blows them up, swells and exten-
 them, not only by filling up their Pores, as
 ter filleth a Sponge, but also in changing it self
 the Substance of the Parts by the Situation,
 Order it obtaineth after so many ways, or manners.
 ut then, when all the Parts are arrived to a cer-
 pitch of bigness into their just proportion, the
 uring Juice contributes no longer to their
 wth by being changed into their Substance; but
 nly preserves them in the same state of bigness,
 filling all their little Chinks and Cels, as Water
 th a Sponge; and this is, what we may call a false
 of Nourishment, to distinguish it from the o-
 . Some have always pretended, that the Blood
 rished the Parts of the Body; but as some also
 e distinguish'd those Parts into Spermatick and
 guineous, or bloody Parts, they have maintain'd,
 the Blood nourished the bloody Parts, and that
Lympha or *Chyle*, nourished the spermatick Parts.
 is distinction of the Parts is useles and frivolous,
 ce they are all contain'd in the Egg, which is the
 e Seed from whence we take our Origen, and all
 rished by the Serosity of the Blood; for the red
 which is called *Fibrous* is only the Vehicle of
 Nourishment.

This

This Opinion is confirm'd by many Experiments. 1st. There is good store of Blood in Animals which are starved to death, but there is no more Consequence left, nor any thing remaining of the nourishing Gelly. 2d. The *Lympha* is coagulated over the fire, like the White of an Egg, which is an evident Proof that it containeth good store of nourishing Particles. 3d. All the Parts afford, or cast up, a *Lympha*. 4th. The *Lympha* serves, partly to nourish the Child in the Mother's Womb. 5th. The Blood of young Animals is always fuller of *Lympha*, than that of old ones. 6th. The Flesh of young Creatures is also softer to make Gellies. In all probability then, it is not the red part of the Blood which serves for nourishment, but it is this viscous, and sweet Serum which thickens when it is put over the fire, and serves for that purpose. This nourishing Juice is a Heterogeneous Liquor, consisting of many Particles of a different bigness and Figure, which are fit to make Bones, Muscles and Membranes: But it is a Homogeneous Liquor which forms and moulds itself, according as it is placed; or ranged, in different Parts.

It is no hard matter to conceive, that such a Liquor, as this Gelly is, should nourish the Parts of a different structure and situation; since in passing thro' the small Filaments of the Parts, it must needs be moulded into several Shapes according to the Situation. For instance, do we not observe that the Rain, which is only Water, nourisheth all the Plants, with the same Roots and Leaves. This Water which, of itself hath no Taste at all, yet is bitter in Wormwood, sharp in Mustard, and sweet in Liquorish, it is solid in the Wood, pliable in the Leaves and Flowers, it is astringent in *Tormentil*, purging in *Rhubarb*, and so in other Plants it hath different Vertues. Nor with what reason can we imagin, that the Water containeth in it so many different Parts? This is impossible, we must rather believe, that all the Vertues of the Plants, and all that diversity of their Parts, proceeds purely from the different Disposition, or Ordering of their Sap.

As to Nourishment, some have said, that there is in the Blood a certain Liquor, like the White of an Egg

g, and another something like the substance of the
 ain, and that one might see on the surface of this
 matter, when it was hardned like the White of an
 egg, certain small whitish Membranes; but this is a
 needless and frivolous Distinction, or Difference:
 for the Parts which they call *Albugineous*, or whi-
 sh, have no Difference from those called *Fi-*
ous, it is still the *Lympha* which turns to a Gelly
 when put over the fire, and formeth little Skins
 strong and thick enough, where there is too great
 Heat.

Besides, the efficient Cause of Nourishment de-
 pends not on any single Faculty, as the Antients
 would have it; nor on any Ferments, as many of the
 Moders do fancy, who are apt to place them in a
 manner in all Parts of the Body; nor yet, in fine, on
 the Diversity of the Pores, but from the Influx, and
 uninterrupted Course of the Spirits. For when the
 passage of the said Spirits is any ways obstructed,
 we may observe, that the Parts do immediately grow
 Lean, because their little Bladders being no longer
 distended, or extended by the Spirits, which used to
 pass like an impetuous Wind, into the narrowest
 parts of them, the nourishing Juice must needs be
 very much diminish'd there. This is what we daily
 see in those Parts, which are paralytick, which are
 generally Lean and Cold, because of certain Ob-
 structions, which check and hinder the Course of the
 Spirits to them.

As to what we say, about the Leanness of the Parts,
 it may be also confirm'd by those who are newly re-
 cover'd of any Sicknes, tho' not perfectly well. For
 what is it that makes People so Lean and Weak then,
 but only the loss of Spirits, which have been
 wasted, and spent, during the Course of their Sick-
 nesses? Besides, the Membranous parts are longer in
 recovering their bulk, than the more Fleshy parts,
 the nourishing Juice having a more difficult passage
 in one than in the other. If, according to this *Hypo-*
thesis, the Spirits of any part of the Body (as the
 Eye) grown Lean, could possibly be weigh'd, it may
 be they would not weigh three Grains, and yet in
 the natural state of the Eye they would, perhaps,
 weigh ten.

All

All lean Persons are commonly weak, languishing without any Vigour, and weak-sighted, which ariseth purely from the want of Spirits, or the too great dissipation of them. But Nature hath so well provided in this case, that she hath furnish'd the Eye with so many Membranes, Vessels, Glandules, Muscles and Nerves; that the Eyes are always in a dry leaness of the Body, the last of all the Parts which are dried up: For among all the Organs belonging to the Senses, none hath more Nerves distributed to them, nor larger, than the Eye hath, the Optic Nerves being, as I may so say, the chief Road, or Tract of the Spirits; and tho' the main business of the Spirits of this Nerve, is purely to keep up the little Threads of the *Retina*, there is yet some reason to believe, that it enters into the *Plexus Choroides*.

CHAP. VIII.

Of Hunger and Thirst.

BY what hath been said of Nourishment, we plainly see, that we must have such Food, which after its having undergone the necessary Alterations for it, may repair the loss of those Particles which are spent, or dissipated.

The Appetite is not created, or raised by any Acid Humor, as all the modern Authors, in a manner, do suppose. But it proceedeth from a certain *Lympha*, that is something saltish, which is strain'd, or filtered in the Glandules of the Stomach: This is that which causeth Hunger, by gently irritating the Fibres of that part. This *Lympha* was therefore supposed to be Acid, because Verjuice, and Vinegar (which are also Acid) do whet the Appetite, and that those Medicines which mortify Acids, do also blunt, or take off the Edge of our Appetite: In the mean while, here are some Experiments that seem to prove the contrary. We see some Persons indisposed, whose Stomach is fill'd with Acids, and who

yet never the more Hungry for that, the Appetite then is not therefore rowled by the Acid that dissolveth the Food. Besides all *Alkalis*, as well fixed, Volatil, and the Aromatick Salts, which have some *Acrimony* in them, are as capable to stir up an Appetite as any Acids: Whence we must conclude, that Hunger or Appetite is not only excited by Acids alone, but also by every Thing which is sharp, and sulphurous; and the reason why *Alkali's*, and all Meats spoil or take away the Appetite, is not because they are of a contrary Nature to Acids, but because they suck up, imbibe and disturb the Salty *Lympha* of the Stomach.

Some ask how is it, that one is more hungry after he hath fasted a long Time, than one is an Hour or two after eating something? We answer, that this proceeds from the *Lympha* of the Stomach's growing more sharp after many Circulations, for thus it irritates the nervous *Fibres* with a greater Force, or Vigour. But in some small time after one hath eat, the *Lympha* is then sweet, and oily from the mixing of the *Chyle* with it, it doth not irritate the Nerves at all. Hence we may give occasion, why Children at all Times, their Food being gentle, and easy Digestion, it remains not long in the Stomach; but by a very swift Circulation, all the *Chyle* is taken up in nourishing the Parts, so that the *Lympha* which presently returneth, and is no longer sweet, must needs irritate the Nerves of the Stomach, and this is the true Cause, why Children are always hungry.

It often happens out, that when one hath fasted a long Time, one loseth one's Appetite; because the *Lympha* of the Stomach, after its several repeated Circulations, is at last divested of its saline Particles which run off with the Urine, and the sharp Oily Salts, remain in the Liver to make *Bile*: To this also we must add, all the Evacuations at the Nose or Mouth, &c. Thus the Liquor being grown sweet, and being diminished as to its Saltiness or quantity, it is no longer capable of producing Hunger.

When one is very hungry, one's Spitte is more plentiful, which ariseth from this, that the *Lympha* is more fluid, or more apt to run, because it is freed and got loose from all its sweet and oily Parts, and

thus the Salivary Glandules separate more of it. One may easily explain at present, why Food appeareth, or takes away Hunger, and why it restoreth our strength, or the force of our Bodies. For first the Food, or Meats we eat, like a Sponge must needs imbibe, or suck up the Liquor of the Stomach, and this must needs hinder its Action. Secondly, The chylification is no sooner over, or perfected, but one part of the *Chyle* floweth into the Intestins, or Guts, which goeth immediately into the milky Veins, and thence passeth into the Mass of the Blood.

Besides the Sense, or feeling of Hunger, there is also another kind of Appetite which is call'd Thirst, which is a troublesome unlucky kind of Sensation, which determines and disposeth us to be always drinking, in order to quench it. We shall see, by what ancient Authors have said of Thirst, that it proceeds from the driness of the Throat, or caused by the *Acrimony* of Salts, or by certain hot and dry Vapours arising from the Stomach. By that we see that Thirst doth not so much proceed from any one particular Cause, as from the Food or Meats which we have eaten, by which one may see that there is a great deal of difference betwixt Hunger and Thirst, for Hunger may be said to be a natural Sensation, or feeling, excited by some particular Cause; whereas Thirst is only an effect of the Food, we have taken. This may be verified or confirmed by the Instance of those Animals who drink not at all.

Yet Drinking is very necessary for us to promote and facilitate our Digestion, as also to steep and soften the *Chyle*, for the easier Distribution of it. Some ask whence proceeds it, that one is troubled with the Head-ach after long Fasting? And why the pain ceaseth as soon as one eateth any thing. This is easily answer'd by saying, that this Pain proceeds from the sharp Particles of the *Lympha*, which were mixed with the Blood, and disturbed the Membranes of the Brain, but as soon as one hath taken any Nourishment, the Pain ceaseth, because the Blood is presently sweetned by the *Chyle*; therefore all those Liquors which filtered or strain'd thro' the Glandules are so much the sweeter.

C X A P. IX.

Of the first Preparation of the Food.

THe chewing of what we eat is so necessary a point, especially when our Meat is hard, that the Spit-
tle would hardly penetrate it without it. The Teeth
serve to grind our Food, with the Fore-teeth we
cut it, and tear it in pieces, almost in the same man-
ner as Beasts of Prey do, but in this, they differ from
us, that they swallow their Prey without chewing it;
thus their lower Jaw is armed with great Fore-teeth
very sharp and cutting, for the better tearing in
pieces of their Food.

There are some Fish which are furnished with the
like, as well as those Creatures which chew the Cud,
which have Fore-teeth very sharp only in their lower
Jaw. The Hare, the Squirrel, the Rat, the Bea-
vour, &c. have these Teeth very long; and they
have them in both Jaws. Man maketh use of his
Dog-Teeth, to grind and break his harder sort of
Food, Dogs have abundance of them, with which
they break their Bones. In some Animals these Teeth
stand much out, and serve them for their Defence, as
we see in Boors and Vipers, &c. the last Teeth,
which are called *Molares*, or Grinders, serve for the
bruising and grinding of the Meat, or Food in Man,
they are very large, and their Superficies is flat and
rough. The Oxen have their grinding Teeth smooth
and polished: Lyons on the contrary, have them ve-
ry rough or rugged, because they use them to tear
their Food in pieces.

All Animals have not Teeth, Fowl or Birds for
Example, instead of Teeth, have their Bills, which
serve them as well.

The Bird called * *Phœnicopterus*, the Swan, the
Goose, have their Bills set with Teeth, for their bet-
ter grazing, or pulling up of the Grass. Among
Fish, there is the Pike which hath abundance of
Teeth; yet he makes no use of them to break or

*ABird hav-
ing a Wing
of a Crim-
son Colour.
as big as
a Hern of
an Ash-co-
lour.*

grind his Prey, but only to catch or take it, and to hold it, that he may the better swallow it whole.

Those Animals which chew the Cud, as the Ox, the Camel, the Sheep, &c. have only Fore teeth in the Lower jaw, in their Upper-jaw they have a round circular hard Rowl or Ridge, which helps them to cut and pull up the Grass by fixing their Teeth in their Lower-jaw against this Rowl, they hold fast the little pieces of Grass, and much better, than if they had fore-Teeth, or Cutters in their Upper-jaw also, because then, the Teeth not coming close every where, many little Bits of Grass would fall into the Spaces betwixt the Teeth. Artists, or common Work-men, make use of the same Artifice, when they have a mind to hold any Thing very fast in a Steel Vice they place a piece of Wood, or bushe-Skin betwixt the Vice, and what they would hold fast.

The Snails which feed on Grass have two blackish Teeth in their Upper-jaw, which are Cartilaginous, and have a certain Spring in them. Those Animals which chew the Cud have four Stomachs, as the Ox, the Sheep, and the Deer, &c. yet the Camel, which also cheweth the Cud, hath but 3 Stomachs. The Birds or Fowl which have crooked Bills, do make use of them to break and tear their Food in pieces, as the Eagle and the Parrot.

Most of the smaller kind of Birds break the Grain and Eat only the softest part of it; but some others swallow the Grain whole, without breaking of it, as Pigeons, Hens, and some others. These last have three Stomachs; the Gizzard or Gizard is the strongest of all; it is composed of four great Muscles which serve them instead of a Mill stone to grind the Grain: The Inside of it is furnish'd with a strong thick Membrane, full of uneven or rough places where the Grain is Lodg'd; so that it is ground as well as if it had been in a Mill. Notwithstanding this callous hard Membrane within it, the sides of it come close to each other, where it is press'd all round by the Muscles, and the reason why it bruises in pieces what it contains, is, that it is rumpled, and as it were button'd up close together by the Action

of the Muscles on it ; and as it is hard, it hath a kind of a Spring and soon returns to its first State: Thus it becometh an *Antagonist* to the Muscles, which upon the ceasing of their own Action, permit it also to Act in its turn.

Birds of Prey have no Gifern or Gizard at all, their Stomach is Membranous like that of Man's and other Animals : This we see in the *Eagle, Hawk, Crane, Stork* and *Hern*, &c. The Gravel and little Flints which are in the Giferns of Birds, do not contribute any thing to nourishment, as some have thought ; but this Gravel serves them in great stead for the breaking and bruising of the Grain, like so many *Dentes Molares*. This Sand or Gravel is so necessary to Birds that make use of it, That if they find none of it, they become Sick, and languish away, because their digestion for want of them is imperfect.

As for these little Birds which break the Grain, we do not see that they make use of any Sand at all, because since they swallow nothing but the marrow of the Grain, which is soft and tender like Past, so they sooner and more easily digest it. *Harvy* observeth, That those Birds which took often Flints, chose only the roughest, or those which are most ruggy, because such are fittest to grind the Grain ; and that when they have been much us'd, and that they are worn polish'd or smooth, they sling them up again, because these Flints, by a too frequent rubbing them one against another, lose their ruggedness, and become smooth ; so that they keep or retain them no longer in their Giferns. But we must not imagine that the Birds choose their Gravel, Sand or Flints, so, they take them indifferently as they lie.

The same Author observeth, That in holding on close to the Bellies of Birds of Prey, as *Eagles, Falcons* or *Crows*, one may perfectly hear the noise of the Flints, which rub or strike one against another ; but he saith, That the Birds must be fasting, This observation sheweth, That those Birds whose Stomach is Membranous do also swallow Flints, as well as those which have a Gifern. It is an Error then to believe, That those Birds which swallow Flints do it from an Instinct that is particular to

them, by which they know they will grind their Food. Besides naturally and strictly speaking, what is the meaning of the word Instinct, it is only a general notion or term that determines nothing in particular? Thus it is said also, that the Cat hath an Instinct to hunt Mice, yet we see the Cat runeth after little Birds, and all other little Animals, which make the same Impression on the Eyes of the Cat, as Rats and Mice do; and so it is in respect of the Grain or Sand which the Birds pick up indifferently without any choice.

Those Animals which the Ancients call'd imperfect, have yet as much perfection in their Organs, as the greatest Animals, as the Ox, the Camel. For Example, there are some Insects which chew the Cud, as *Grass hoppers*, *Crickets*, and the *Grillo-Talpa*, which is a very large and greedy Insect; they have all of them three Stomachs. Those of the *Grillo-Talpa* are very large in respect of the Animal. The first resembleth the little Leaves of the third and fourth Stomach of those Creatures which chew their Cud.

Amongst Insects, there are some great ones which chew their Food, and there are also some others which are lesser, as several *Flies*: The *Bees*, the *Hornets* and *Wasps* are of this number, Upon the approach of fine Weather, and towards the end of *May*, the *Bees* begin to make Hony, they go out to suck in the Dew and Juice of the Flowers; and after that these things are digested, and have receiv'd the necessary Preparations for the composing so sweet and pleasant a Liquor, they return to their Hives in order to vomit or cast it up into their little Cells. Perhaps it is for the nourishing or feeding of their Young Ones, for it is, at that time, that the first Brood of them is hatch'd, which is only an Embryon in the shape of a Maggot or little Worm, which by the heat of the Spring is hatch'd. This Maggot is white, and afterward it changeth or putteth off its Coat. As weak as it is, it descends, or cometh down below from the first Appartment, and seats it self on the Benches, and all round the Hives where the elder Mother-*Bees* nourish them till they are able to go into the Field to seek their own Food.

We must observe here, That the Wax, which is first Liquid, and which surrounds this little Worm, is of the same use to it, as the Yolks and Whites are to a little Chick, when it is in the Egg. If the Wax is three Years old, it is no longer fit for Nourishment.

In fine, the *Bees*, to pass away the Cold Winter, retire to their Hives, which after they have laid in sufficient stock or provision for that Season, they seal up with little pieces of Wax. But in the Month of May, the Hive is laid open, in order to enjoy the sweet Air of that Season.

The *Wasps* also build themselves an admirable House or Lodging, there are Apartments in it so well ordered and contriv'd, that it surpasseth the Skill of any Architect whatever; they also make a kind of Hony, which they cast or vomit up again in their little Cells, for the Nourishing of their young Ones, which are tender and delicate little Maggots. The *Hornets* also do the same thing. These *Flies* are so greedy, that tho' they are cut in two pieces, they still eat on, and if it is Hony, one may see it run down like Dew.

But before we go any farther, I must tell you, it is an old Error to imagin that the *Crocodile* moveth his Upper Jaw, for there is nothing more false than this, since the Bones of this Jaw are very exactly join'd or riveted to those of the *Cranium*. There is something very particular in the structure of the lower Jaw of this Animal, for the easier opening it, on the other side where it is Articulated, there is a kind of an end. This place resting it self against the Bone of the Temples, when ever the Muscles draw this end upwards, the Chin, at the same time, falls downwards, and this is the reason why the *Crocodile* opens his throat so wide.

The Reverend Fathers of the Society, in relation of their Voyage to *Siam*, are deceiv'd, as well as the Ancients, when they say the motion of the Upper Jaw of this Creature is more sensibly perceiv'd, than that of the lower Jaw; or that there are more Muscles in the Upper Jaw, than in the Lower one; and that they are convinc'd of this Truth by the dissection of three *Crocodiles*. But they must know, that

the Muscles above contribute only to the motion of the Head. That which hath hitherto deceiv'd all the World in this point, is this, that we scarce ever see any but such *Crocodiles* as are dried up, whose Skin is exactly glued and hardened on the Head, and to shew that the Upper Jaw is moveable, they take the Head and shake it on the Lower Jaw, which shatters and breaks in pieces the Skin where it was join'd to the Back bone; so that the Flesh below, which covers the lower Jaw, being very thick, stuffed up and dried, all the pieces seemeth immoveable. If we will be satisfied in this point, we must not Examine the *Crocodile* when it is dried up thus, but we must take off the Skin from the Head and cleanse it, and then we shall see that the Bones of the Upper Jaw are articulated or join'd with the Bones of the *Cranium*, as it is in a Man, and all other Animals.

Before we finish this Chapter of the first preparation of Food, we shall observe, That besides the Salivary Pipes which serve to wet or water the Mouth, there is also a new one which Mr. Nuck by chance discovered, as he was preparing the Salivary Pipes and *Canalis Nasalis* of a Dog which he dissected; at three lines distance from *Scenos's* Salivary Pipe, he met with the Orifice of a Pipe on the other side, at first he could hardly get in the end of a Bodkin, but in pushing it, he made it enter about an Inch. Another time he found it on the other side. This Pipe taketh its Rise from a *Glandule* that is seated within the Orb of the Eye, betwixt the *Musculum Abductor* of the Eye, and the Upper part of the Cheek bone, it cometh out thence in several small Branches, which afterwards Unite themselves into one Conduit or Pipe. He that would view this *Glandula* at these Branches more exactly, must break the *Zygoma*, and then he will see this Pipe which goeth strait on the Out-side near the *Maxillari* in order to open its self about the faced Cheek Tooth, reckoning from the last.

This Excretory Pipe is not always of the same length; it is bigger or less, according as the Animals have a bigger or shorter Snout. In great Dogs this *Glandula* commonly weigheth half a Dram, or two Scruples. In the greatest part of Animals this *Glandula*

Glandule is not of the same Figure, it is sometimes round, oval, flat, and sometimes Triangular. Those Glands of the Eye, and the *Motores* are distributed

This Glandule is better seen in a Dog that hath been strangled, even the smallest Ramifications of Vessels do then appear visibly; and one hath greater Satisfaction in this point by Injection, it may be made by the *Carotides*; one may see all the Villaries of the Arteries, which are twisted about the Branches of the Excretory Pipe. And if one would take the Wax pass into the smallest Branches, one may put in with it good store of Oyl, which must be melted to make it run the better, and thus all Injections are to be prepared. This new Salivary Conduit, is called the Upper-one, to distinguish it from that of *Steno*.

After the Food is ground in pieces, and well soak'd in the Water which floweth from all the little Glands in the Mouth, this kind of Paste is push'd on the Tongue, which like the Sucker of a Pump draws it into the *Oesophagus*, which straightens it self in the upper Part to keep in the Food, and it is the closing together of this Membranous Sack or Bag, which by the contraction of its *Fibres* pusheth on successively every thing that is to descend into the Stomach. The Liquor also which runs from the little Glandules of the inward Membrane of the *Oesophagus*, facilitates the descent of the Food into the Stomach. The Food being once got down into the Stomach, there digested and soak'd thro' a flesh, with a *Salsa* that is sweet, and something Saltish; and as we shall examine in the following Chap-

CHAP.

C H A P. X.

Of Digestion.

THe Food is no sooner got down into the Stomach, but the several Beds of fleshy *Fibres* shut up themselves, in order to retain the Food more closely; and as by this Contraction many uneven parts are formed, they help very much to move the Food up and down. This Contraction is very proper to squeeze out of the Glandules the Menstruum or Dissolvent, that is to serve for the Digestion.

During these Motions, the two Orifices of the Stomach are closed, but not so exactly as it is thought for the upper Orifice is not so closed by the Circular *Fibres*, as it hath been hitherto thought; but it is closed by the Contractions of the Stomach assisted by the Motion of the upper and fleshy *Fibres* of the lower Muscle of the *Diaphragma*; yet so, that the Food which cometh a fresh may dilate or widen it for its descent into the Stomach. In fine, in the natural state of the Stomach, no Winds or Vapours should pass out at this Orifice, especially when there is no extraordinary Motion in the Stomach.

The lower Orifice of the Stomach is also stopped up, by a rising, that is form'd by the Glandular Membrane, which serves like the Cock of a Fountain; thus we see, that neither Excrements nor Vapours can pass into the Stomach, unless when the stopple which shuts up the *Pylorus* is something defective. We must yet observe that this Orifice is not so closely shut, but that it is in a manner half open always, for the freer passage of the *Chyle* into the Intestines; for as soon as it is made, it flows by little and little into the *Duodenum*.

Some of the Moderns pretend, that the *Chyle* is not made in the Stomach, but in the Intestines, because they say they, there is no *Chyle* ever to be found in the Stomach of Animals, but only a crude and undigested Food. They add also, that if the *Chyle* was made

omach, we should discover some *Vena Laeua* seated
and one would often vomit up *Chyle*. These
difficulties are easily solved or clear'd, when we con-
sider that the *Chyle* in the Stomach is mixed with
Excrements, for it is only clear'd from them in the
Intestines.

The *Chyle* in the Stomach, is in a manner like
Essences which are not filtrated, and yet are ex-
tracted; so also the *Chyle* in the Stomach, tho' mixed
with gross Particles is yet still *Chyle*, for these strange
Particles will not remain always with it. By that
reason no *Chyle* can be vomited up, since in the Sto-
mach it is always confounded with the Excrements,
as well as when it is in the Intestines, for the *Chyle*
is never pure there, as it appears evidently in the
Excretion of living Creatures, even when the *Chyle* is
in the Intestines.

As to the Milky Veins, which cannot be found at
all in the Stomach, must we therefore conclude that
the *Chyle* is not made there? This is what I would
rather affirm or deny.

In fine, there are three famous Hypotheses for the
explaining of the Digestion, the first is of those, who
pretend it is performed by the Heat of the Sto-
mach and Bowels which are near it: Others main-
tain, that the Dissolvent or Menstruum of the Sto-
mach is acid: In fine, the Followers of the last recur
to Fermentation.

To shew that Digestion is not the effect of Heat,
let a Body be never so hot, the Heat changeth not
the substance. Boil Meat as long as you please, and
it will never turn to *Chyle*, as Food in the Sto-
mach doth. Fish which have no heat at all, yet per-
fectly digest well. In fine, many hard Substances
which Heat could never dissolve, are yet digested in
the Stomach of Animals.

It is a long time, that some have pretended, that
Digestion was perform'd by an Acid, for besides the
Heat of the Stomach, they pretend that a certain a-
cid Humour called *Atrabilaris*, is conveyed thither
from the Spleen. These Authors have had many
followers, and all the Moderns in a manner have
maintain'd that Digestion was perform'd by an A-
cid; but none hath defended this Opinion among
all

all the Moderns more warmly than Helmont. These here, are his strongest Arguments in favour of it.

1st. There cometh out of the Bills of Birds a certain Vapour, which smelleth of an Acid. 2d. There are many Birds that swallow Flints and Sands, to mortify the Acid of their Stomach, which irritates the Fibres of it. 3d. The sweetest Food, preferment groweth sour in the Stomach. 4th. Vinegar, and the Juice of a Limon, create an Appetite. 5th. In Diseases, it is a good Sign when one is troubled with sour Belches, because it is a Sign of a good Digestion. 6th. After the taking of Steel Lozenges, one perceiveth acid Belches, which smell of Sulphur. 7. If one vomits Milk fasting, it is always curdled like Cheese.

To Answer, or over-throw these Reasons, we shall oppose to them, so many Experiments that are contrary to them. First, they say, that the *Lympha*, which is in the Stomach of Animals which are fasting, is always sweet, and as insipid as Spittle, which if it mixeth with any Alkali's, there would happen no Fermentation at all by it; which yet would certainly be, if the *Lympha* was Acid. Mix it with the Syrup of Violets, it will change the Blue Colour of it into a Green, but it will not be Red, as it is when it is mixed with Acids. If one observeth any Acidity in the Stomach of those Dogs, which are fed with brown Bread, there is no such thing to be met with in the Stomach of those Dogs which feed on white Bread, and other sweet Foods, as Flesh or Milk, for there is never any sour Thing in their Stomach. In fine, if the Liquor of the Stomach becometh Acid, this Acidity is not natural to it, for it proceeds from the Food, or some Indisposition in the Stomach.

When they say, that there ariseth from the Bills of little Birds an Acid Vapour, they must not therefore infer, that there is any Sourness in their Stomach; this Vapour may arise from the Food they have eat, which may be grown sour. Neither is it true, that Birds do swallow Sand and Flints to mortify, or blunt the points of the Acid, for this Grave serves them only to break and grind in pieces the Grain, as it hath been already shewed. As to Food

Quals, they do not all grow sour in the Stomach, but only such as is already Acid, or that may be so by Fermentation: As for Example, sweet or Sweet-meats, &c. Acids do not always kill an Appetite, but only in those Constitutions which are bilious or Phlegmatick.

Those sour Belches which happen in Diseases of the Stomach, do not always shew a good Digestion, but an imperfect one, which will at length be cured, as soon as the Leavens of the Stomach have recover'd their first sweetness. If sour belches arise upon the taking of the Steel-Lozenges, is no Argument, that the Dissolvent of the Stomach is Acid, since this Accident seldom happens, but to those whose Stomachs contain much sourness in them; for if one pour Water into the Filings of Steel, the Mixture smells acid and burnt. Milk will be always curdled in the Stomach, without the addition of any Acid, since this Effect may arise from the Acids, some of which will curdle Milk. The rest of the Chyle that may sour by its continuing there in the Stomach too long, may also curdle the Milk.

All these Reasons then, sufficiently shew that Digestion is not perform'd by an Acid; and we must therefore think, that all Dissolvents are acid, since we learn by Chimistry, that some Dissolvents are *Alkaline* and sulphurous.

The Authors which have recourse to Fermentation for the Work of Digestion are very numerous, and they say, that Heat of it self is not sufficient, but there must be also some Ferment to open, or unloose the Principles of the Food or Meat we eat. But we must here observe, that Fermentation may also assist Digestion, and that every Thing which easily fermenteth, (as Fruit, and sweet Wine) is not digested without much difficulty, if one eateth much of them, one is troubled with sour smells and belches, and is pained with Gripes, which are the Effects of Indigestion. On the other side, the Food which is not easily fermented, as fat Meat and Bones are easily digested; and if one distilleth them when they are half digested, there is no Sulphurous Spirit arising from them, which would be, were our Food digested by Fermentation. What is here said, is enough to shew,

shew, there is no Fermentation in the Stomach but when it is indisposed, or out of order.

They who are persuaded that Digestion is attended with some kind of Fermentation, prove it from That the Food loseth its Taste and Smell; That the Liver or Spittle putteth out Viſuals in a ferment, which being rarified, take up more room in the Stomach. But all this may happen without any Fermentation. First, the Menstruum or Dissolvent of the Stomach cannot insinuate its self into the Pores of Food, without dividing the Particles of it from each other, and changing their Situation or order, and this is done by degrees, according as the Dissolvent penetrates the Food for the separating of its Principles, we should judge from thence, that Digestion is not a Fermentation, but an extract of the Principles of our Food, from the equal mixture of the Dissolvent with it, and this is that Tincture which is called Chyle.

There is found a Lympha as clear as Water in the Stomach of those Animals which are Fasting; after they have eat any thing, it is thicker and more troubled. In Living Animals it is as very clear Water, and it abounds more or less; on the contrary, those Animals which have been dead, for some time, it is always thicker and more viscous. In fine, it is what we cast up when we are Sick at Stomach, sometimes vomit up in a Morning before one has eat any thing.

The Antients took this Humour for an excrement with little reason, since this Liquor, which is very pure, is mix'd with our Food, in order to Dissolve it. It is never thick but when it is degenerated from its natural State. There are some who have derived it from the Arteries, but we are well satisfied that Nature maketh use of no such Organs in her Filtrations: This Liquor hath no other Source or Rise but from the Salivary Glandules, and those belonging to the Stomach.

As to the Spittle, tho' our frequent Spittings consist of a good part of it, yet there always descends enough of it into the Stomach when one eateth, it falls into the *Oesophagus*, without any motion of the Jaws, as it happens in our sleep. As for those Animals

Stomach Spit not at all, & their Spittle goeth down in-
 their Stomach; no if it were true that the Spit-
 was an Excrement, as the Antients would have
 it should hinder the Digestion; but it is so far
 from hindering it, that it dissolves the Food, being
 mix'd with the Dissolvent or Menstruum of the Sto-
 mach. The Glandulous Coat, or Membrane of the
 Stomach, is placed under the fleshy one, and as it is
 wrinkled, it maketh several wrinckles. It is not
 every where of the same Colour, at the Upper Ori-
 fice it is whitish, as it is also about the middle of it,
 it is red every where else, unless it be towards
 the Pylorus, where the Bile gives it a yellow Tincture.
 This Coat or Membrane is spread all o'er with a cer-
 tain Glew, which is not easily got off. There are
 several perpendicular Pipes, which rise up about the
 bottom of the Stomach, which are all Excretory
 Conduits of an equal length, being join'd to each
 other at the end, which hath occasion'd some to think
 it was another Membrane, but yet it is altoge-
 ther impossible to separate it without tearing it in
 pieces.

Mr. Mah-
 pigghi, in
 his late
 Letter to
 the Royal
 Society
 of Eng-
 land.

This heap, or bundle of Pipes, is supported by a
 nervous and membranous kind of Net-work, whose
 fibres appear very visibly, if you only pour a little
 Liquor on it. All this is yet more apparently visible in
 the Stomach of a Sea-Dog, or that of an Eagle.

In those Birds which feed on Grain or Corn, the
 Glandules are in the Craw; they are very big in the
 lower part of the *Oesophagus*: There are none in the
 cartilaginous Membrane of the Craw, because that
 is performing the Office of a Mill-stone by means
 of the Sand which is always there, if there were a-
 ny Glandules they would soon be torn by the rub-
 bing of the Sand against them.

Tho' we have shewed that there is no Acidity at
 all in the *Lympha* of the Stomach, yet some perhaps
 will say that it is an occult Acid, but why should
 any one imagin an occult Acid in this Liquor, since
 this Phenomenon of the dissolving of the Food in the
 Stomach, may be rationally explain'd by the Motion
 only of the Saline Particles of the Dissolvent? In
 short, this Humour of the Stomach, which some sup-
 pose to be Acid, is nothing else but the *Lympha*, which

is filtrated thro' those Glandules of the Stomach which we mention'd before : And as the *Lympha* in its natural state hath no Acidity at all in it, either in the Blood-Vessels, or in the *Lymphaticks* ; How should it come to be acid in the Stomach, since it suffereth no change, or alteration, by its being filtrated in the Glandules of that part ?

This spirituous *Lympha*, by its watry and fine Particles, penetrateth the Food, in order to draw thence a Tincture ; it imbibes in all its milky and mucilaginous Substance ; it mixeth it self with it, and, according as this Meat aboundeth more or less with this Substance, it yieldeth more or less *Chyle*. Thus we see, that the turning of Food into *Chyle* is not the changing of one Substance into another, as *Van-Helmont* saith, but it is a separation of the mucilaginous part of it, by means of the *Menstruum* in the Stomach. And to facilitate the separation of it, there always precedes some small motion of Fermentation, which disposeth the Food to produce the Tincture the more easily. But this kind of Fermentation is nothing like that of an Acid with an Alkali, but it is a more gentle Fermentation, which either proceeds from the Food it self, or from the Spirit of the Dissolvent of the Stomach, or, in fine, from the remainders of the *Chyle*.

The Heat of the Stomach, as also of the neighbouring Bowels, with the Motion of all these Parts, are very necessary for Digestion ; for Heat, by putting the Particles of the Dissolvent in action, prevents their adhering to each other, and their thickening, whence they become more sharp, and more penetrating ; and this is the Reason, why Hot Meats are always sooner digested than Cold, because all the Particles are in action, and in a disposition to move themselves. It is true, that the Motion of the *Organs* is altogether necessary to carry on the Work of Digestion, because our Meat, or Food, is kneaded in a manner, in the Stomach, by the Muscles of the Belly, and the *Diaphragma*, which continually, and at several times, press the Stomach together, and squeeze it.

Kyperus.

Some have gone about to determine, in what time our Food is digested ; they say, that the true sign of

being perfected, is when we are hungry; but we do not always tarry till the Digestion is over, because we eat, as to that we are govern'd by Appetite and Custom, for some are in a manner always eating; no one cannot exactly determine the Time in which the Digestion is finished, for it is sooner or later, according to the Food we eat, since we do not feed always on the same Thing, and we sometimes eat more, sometimes less, sometimes the Meat is cold, sometimes of hard Digestion; and as they differ in their Preparation, they require more or less Time for their Digestion.

For Example, Soup or Porridge well soak'd over the Fire, thick-Milk and new-laid Eggs are more easily digested than Meat; a small quantity of Meat is sooner digested than a great deal, and Things well wil'd, are sooner digested, than Things that are raw.

Those Bits or Pieces which have been well penetrated, or soak'd thro' with Spittle, are not so long a digesting, as those which we swallow without chewing. In fine, the Digestion is sooner, or later finished, according to the Constitution, Age, or Custom, and many other Circumstances of People, which are easily known.

For Example, the Work of Digestion is sooner finished in young Children, than it is in old Persons. Students and Scholars have usually weaker Stomachs, than those who are employ'd in harder or more Laborious Professions, as Tradesmen and Artificers. Amongst Animals, the Wolf and the Dog have the quickest Digestion. In the Stomach of Pikes, and other greedy Fish, there are often found other Fish half digested, part of which continues entire, and whole in the Throat of the Pike, whilst the other part of it, which is in the Stomach, is perfectly digested; thus we found an Eele, half of whose Body was entirely digested, and that part of the Tail which was Living, came out at the Throat of the Fish.

Nor is the Digestion equally well accomplish'd even those of the same Constitution, because the Lymph of the Stomach being not always in the same quantity, and being also more Spirituous at one

G Time

Time than at another, the Digestion accordingly must needs be sooner or later finished. But generally speaking, it is finished in six or seven Hours Time, and sooner by Day than by Night.

We must not imagine (as most Authors do) that it is the Stomach only, which contributes to the Work of Digestion or Perfection of the *Chyle*; the Intestins or Guts, have also their share in that Work and they are composed of the same Substance as the Stomach is, and make but one continued piece, they are also furnished with Glandules for the filtrating Liquor or *Lympha*, like that of the Stomach, which bringeth the *Chyle* to its last Perfection, by clearing it from its grosser Particles. Let us see how they have explain'd this last Perfection of the *Chyle* in the

Helmont. Guts. Some have suppos'd that the *Chyle* was acid since Digestion was made (as they fancied) by an acid Ferment, so that being mixed with the *Bile* in the *Duodenum*, it grows sweet, because the *alkali* of the

Sylvius de la Bo. *Bile* doth there precipitate the Acid. Others have said, that the *Bile* and the Pancreatick Juice raised a certain Fermentation, which cleared the *Chyle* of all its Excrements. But it is certain, that the *Chyle* is never acid in its natural state, as we have proved. As to the *Bile* it doth not ferment at all with the Acids, nor with the Spirit of the *Vitriol*, nor Spirit of *Salt*, we only observe that this Mixture makes a kind of Curd, which is not always of the same colour nor of the same consistence; for the colour alters according to the Acid that is mixed with the *Bile*. We must also observe, that Acids do not coagulate the *Bile* of most Animals: The Spirit of *Salt* for Example doth not coagulate the *Bile* of a Dog at all, it only renders it green. All Experiments shew, that *Bile* doth not precipitate the *Chyle* at all, and that the Pancreatick Juice is no wise acid, and that no Fermentation ariseth from the mixing of *Bile* with the Pancreatick Juice.

But some will be apt to say, what is the use then of the *Bile*, since you take from it those Qualities which have been ascribed to it? To this we answer that the *Bile* serves for nothing else but to dissolve the *Chyle*, and to render it more thin and fluid, to the

it may carry no Crudities into the Mass of the Food. For as soon as the *Bile* faileth, or that it is anything changed in its nature, the *Chyle* is presently deprived of that thinness which is so necessary for its perfection, therefore upon the defect of the *Bile* many Diseases are apt to succeed, as Dropsies and Fluxes, Loosness, &c. Beside as the *Bile* rendereth the *Chyle* more liquid, and more fluid, it also raiseth, or createth an Appetite: For in those greedy Animals which devour much Flesh, and whose Digestion is not finished, as in the Woolf, the Conduits or Pipes of the *Bile* open into the Stomach. The same hath been observ'd also in some Men, as in that Gall-yeve, which *Vesalius* speaks of, who was very voracious and greedy, and was never Sea sick.

The *Bile* is not the only Liquor which is pour'd into the Guts: there are also two others, which are the Pancreatick Juice, and the *Lympha* of the Glands in the Guts, which are all mingled with the *Chyle*. These two *Lympha's* differ not at all from the *Lympha* of the Stomach, as we have said before. We have always found the Pancreatick Juice as sweet as the *Lympha*, besides if there were any Acidity in it, it would coagulate the *Chyle*, as the Runnet doth Milk. Thus the *Lympha* of the *Pancreas*, by steeping and mixing the *Chyle* with the *Bile* it grows more fluid, and more easily passeth into the milky Veins.

We have said also, that the Liquor of the Glands which are in the Guts, serv'd also to wash the *Chyle*, as well as the *Bile*, and Pancreatick Juice; but it serves for nothing else how comes it, that there are more Glandules in the lower part of the *Ileum*, where there are more milky Vessels, and less glandules; one may then believe, that this *Lympha* serves also to keep the Excrements soft for their easier passage.

After all that hath been said, one may very well conclude, that the *Chyle* is nothing else but the Particles of the Food dissolved by the *Lympha* of the Stomach and the Guts, which being mix'd with each other, do constitute but one Liquor, which seemeth to be composed of certain little globular Parts as clear and transparent as Chrystal swimming on the Surface of this Liquor, which is very clear, as one may observe by the Microscope.

Some are apt to ask whether the whiteness of the *Chyle* is natural to it, or whether it doth not sometimes receive that Tincture from the Food one hath eat; For there is a considerable difference betwixt the *Chyle* which is pure, and that which yet continueth fetter'd in its grosser Particles. For Example, when it is not yet arriv'd to its perfection, it is grayish; but it is as white as Milk, when it is clear'd from the Excrements, and passeth into the milky Veins.

In those Animals which feed on Grass, as the Horse, the Sheep, the *Chyle* and Excrements are greenish, and retaineth always the Tincture of the Grass.

Willis.

I lay down here a Problem on the occasion of the *Chyles* being so white in Man, notwithstanding they feed on such diversity of Meats. Some have conjectur'd, that the whiteness of the *Chyle* hath proceeded from the *Sulphur* and *Volatil Salt* of the Food mixed with the Acids of the Stomach, just as the *Spirit of Harts-horn* grows white when it is mixed with an Acid. But where the Acids being mixed with the *Spirit of Harts-horn* render the Liquor white, it is only a beginning of its precipitation, and as soon as that is over, the Liquor reassumeth its first Transparency, as it is in *Lac Sulphuris*; it is not so with the *Chyle*, its colour is always the same in the *Vena Porta*, and the *Canalis Thoracicus*. Besides there are no Acids in the Stomach, as we have often said before.

Sulphur and *Salt* are not always equally proportion'd in all Food; therefore it is more reasonable to believe, that the whiteness of the *Chyle* proceeds from the mixture of the oily and mucilaginous Substances of the Food with the Dissolvent of the Stomach, which is loaded with it: For as often as this *Lymph* is imbib'd, or impregnated with the milky part of the Food, there is always a white Liquor, which is called *Chyle*; which reassumeth its Transparency, when the mucilaginous Part is separated from it by Circulation.

C H A P. XI,

*that Perfection which the Chyle receiveth
in the Intestines or Guts.*

HAVING already spoken of the change and alteration of the Chyle in the Guts, it is now time to observe after what manner this Liquor is clear'd from the Excrements, and how it receiveth its last fineness.

They who supposed that the mixing of the Chyle with the Bile produced a Fermentation (have said) that the gross Particles were immediately separated clear'd from those which are more subtle. Others would have it, that this separation was occasion'd from the mixing of the bile with the pancreatic juice; but there is no need of Fermentation in this sort, since the Chyle hath been already separated from the grosser Particles in the Intestines, and wants nothing but filtrating for its entirely quitting of them. For this effect the Bile is altogether necessary, not that it causeth any Fermentation, but because by virtue of its sharp and lixivial Salt it dissolveth the viscous Chyle, and renders it more fluid; so that of its self, that is by its liquidity, and the Peristaltic motion of the Guts, it attaineth a free passage into the *V. Lactæ*.

For a further confirmation of this Point, that the Bile dissolveth the Chyle by rendring it more fluid; we see, that in the Disease call'd Lieuterie, the Chyle is carried off with the Excrements; because the Bile running into the *Duodenum*, as it us'd to do, the Chyle there becometh thick and viscous; thus, it cannot pass into the Milky Vessels, it returns with the Excrements. Now to shew you, that the Bile is altogether necessary to clear the Chyle from its gross Particles, I propose this Experiment: Make a Ligature on the *Jejunum* of a Dog, at that place when the Chyle is a distributing, and another

ther on the Pancreatick conduit, the Chyle in the Intestin or Gut seemeth full of small greyish dots or lumps, which have no Connexion or Conjunction with each other, but the Chyle in the Stomach seemeth all uniform, and of the same consistence.

Nothing remains in the bigger Intestins but the grosser Particles of the Chyle, which could not pass into the Milky Vessels. They say these Excrements are the remainder of the first Concoction, but they should also add of the Second and Third, because Fluxes of the Belly or Looseness, the Sweat and Urine which are said to be the Excrements of the Second and Third Concoction are much diminished, and when the Flux is passed, they return to the first State. By that it appeareth that the Excrements always carry off with them something that might have turn'd to Sweat or Urine. As to the ill smell of the Excrements, some believe it proceeds from a certain corrupt leaven in the Dung, that is contained in the *Intestinum Rectum*; but it is hard enough to conceive how Nature, which of its self never tends to corruption, should produce any ferment, when by mixing it self with the Excrement, should presently corrupt them.

Besides the Chyle and Excrements which remain mix'd in the lesser Guts have an ill smell also, when they are yet descended into the *Cacum*, and other Intestines. This ill smell then is not derived from the greater Intestines, but rather from the Stomach, which begins to communicate this Odour to the rest, then when the Lympha openeth the Principles of the Food. The Excrements of Animals have a different smell from the diversity of their dissolvents. The Excrements of Dogs, for Example, do not smell like Humane Excrements, and even bred in their Stomach, hath another distinct smell, than that which is in the Stomach of a Man, which comes only from the diversity of the dissolvents.

The Intestines have a long time been divided into small and great, but this difference is not to be taken from their Membranes, which (as they say) is thicker in the great Guts, and finer or thinner in the small Guts, for the *Duodenum* is thicker than the *Cacum* and *Colon*, neither can this difference be taken

from their Substance, since that is the same in both; but from their bigness or large bulk, for thus the *Chyle* must be reckon'd in the number of the small Guts; but this difference is certainly derived from the matter that is contain'd in them, which is commonly fluid in those Guts, which are call'd the small Guts, and more gross in those which are commonly call'd the great Guts.

The Intestines have a particular motion, in a manner, like that of an Earth Worm, which is commonly call'd *Peristaltick* or *Progressive*. This motion is effected by a fleshy Membrane, which is composed of two Beds of *Fibres*, the inward whereof consists of thick and circular *Fibres*, which are fastned to the Circumference of the *Mesentery*, as to their Tendon; so that being thus contracted, the Milky Vessels are thereby more disposed to receive the Chyle: The outward Bed is made up of several *Fibres* in length, or longways, which, with the first, make so many Rectangles. If you have a mind to see the order and natural Disposition of these *Fibres*, you must steep them in Vinegar for two days more, and then by blowing them you may see them separate of themselves to your great Satisfaction.

This Muscle or Fleshy Membrane of the Guts cannot contract it self without lessening the Diameter of the Guts, and as the Longitudinal *Fibres* grow shorter, they also render the Conduit or Pipe much the straiter. This motion is not immediately continued from one end to the other, but it is perform'd successively, and at several times carry'd along the Guts like that of the Worms. This Mechanism is altogether necessary for clearing the Chyle from the Excrements, and for promoting its passage into the Milky Vessels.

The *Valves*, which, at a certain distance from each other are plac'd in the Intestines, contribute very much to the retarding of the descent of the Chyle; but as they are fastned to the circular *Fibres* of the fleshy Membrane, so they follow its motion; and this brings the Chyle nearer to the inside of the Pipe, so it passeth the easier into the Milky Vessels.

*Physical
Essays of
Mr. Per-
sault. Rom.
3.*

*Kerkerin
obser. 9*

As Nature is always wonderfully ingenious in contriving several Machines: In some Animals there is a certain spiral thin Membrane which reacheth from one end of the Intestine to the other, especially when it is short, that the Chyle may be the longer in passing thro' that little space, like the winding or flight of a Stair-Case. This kind of Machine is observed to be in the Sea-Fox, the Hare and the Ostrich. There are certain Fish (as that which is call'd *Muraena* or *Galeus Glaucus*, the grey colour'd *Lamprey*) which in their Guts have a large Membrane rowled up like a Coffin of Paper which Grocers use.

As to the *Valves* of the Intestines, it is a long time since the *Valve* of the Colon hath been discovered which is thick, and hinders the Excrements from returning into the *Ileum*; but we shall do well to observe, that this *Valve* is double, and is composed of two little small Skins which join themselves together to stop or shut up the Intestine, as the *Valves* of the Veins do. Besides the *Valve* of the Colon, there are also little Cells in this Intestine, which retard the descent of the Excrements, with *Valves* at a certain distance from each other, not only in the Colon, but also in the Jejunum. These last *Valves*, which nobody ever mention'd before Mr. Kerkerin, do not entirely stop up the Cavity of the Intestine; but they are always a little open, whence the Excrements descend only by little and little; for none of them taking up more than about half the Cavity, and being larger on one side than on the other, they have a room enough; so that the largest part of the lower *Valve* answereth the narrower part of the Upper *Valve*, which hindereth the Excrements from falling down, or precipitating it self all at once into the lower Intestines.

These *Valves* are greater in the Colon than in the Jejunum; as they descend, they insensibly grow less. There is no discovering of them without great dexterity; you must not blow into the Guts, for then you would see nothing, but you must open them to see the inside of them; they may also be seen better if you let them dry.

It is not enough that the Intestines contract themselves at several times, to make the Chyle enter them

in, but the Muscles of the Belly must also press it
 as we said before: The sides of the Intestines come
 close to each other, and as the Chyle in its passage
 moveth also along their sides, it must needs pass into the
 Orifices of the *V. Lactea*, and as the Peristaltick mo-
 tion is continued, it still pusheth it further, like the
 stroke in a Pump. By that it appeareth, that this
 motion is not only intended for the Passage of
 Chyle into the *V. Lactea*, but afterwards to carry
 it farther when it is once got there.

As soon as the Chyle is got into the Milky Vessel,
 that which is left behind in the Guts beginneth
 to thicken, and to be of another consistence. These
 Excrements are more fluid in the small Guts, and
 more gross in the great ones; some ascribe the Ex-
 cretion of these Excrements to the acrimony of the
 Bile, which, as they pretend, serves instead of a na-
 tural Glyster. But this their Passage is purely deriv'd
 from their own weight, and the motion of the In-
 testine; for the bulk of the Excrements may so
 distend the Intestines, as to cause a discharge of them.
 And since, if the Bile doth any way facilitate the Pas-
 sage of the Excrements, it is not by irritating of the
 Guts, but only as in mixing it self with the Excre-
 ments, it washeth and maketh them more slip-
 pery.

The Bile hath been always thought to contain in
 it much acrimony: it's true, that in tasting of it, it hath
 a bitterness with it, yet we must not therefore con-
 clude, that there is Acrimony enough in it to irritate
 the Nervous Membrane of the Intestines; for if it
 had this pretended Acrimony in it, so as to stir up
 the discharge of the Excrements, much more would
 it irritate its own Bladder, which yet it never
 doth, unless when it is degenerated from its natural
 State or Consistence. The Excrements also in their
 natural State are free from all acrimony, since all the
 Liquors which have wash'd them are sweet, and no-
 thing happens to them a fresh, to give them this Acri-
 mony or Sharpness.

When they are once got down into the *Intestinum*
Gracile, they stiffen it by filling up all the Orifice
 of the Sphincter, whose *Fibres* they stretch, and so
 enlarge the Passage; we must here add also, the mo-
 tion

tion of the Belly, which inwardly preffeth them with great force, so that the Excrements must be thrust downwards. Thus, with a continual effort they still widen the Passage the more ; and as the Orifice above is stop'd or shut up by the Valvulae the Colon, the Excrements reflect back, (as I have so say) and so are oblig'd to pass out.

CHAP. XII.

Of the Course which the Chyle taketh when it entereth into the Mass of the Blood.

Vanhorn.
Swamer-
dam. Mr.
Perrault.

Swamer-
dam.

Steno af-
ter Harvey.

THO' it is certain that the *Chyle* passeth thro' the *V. Lactea*, yet there are some modern Authors who will not subscribe to this truth. There is a necessity of proving, that the *Chyle* entreth the milk Vessels, this is visible after the Digestion is over. They who contend, that all the *Chyle*, or only a part of it, passeth thro' the Meseraick Veins, prove it from certain Birds, which have no *V. Lactea*. They say also, that in those Animals which have them they are too small to receive all the *Chyle*, especially in Animals of a very quick Digestion ; and that the whiteness of these Vessels proceeds not from the *Chyle*, since nothing passeth there but Water : To which they add, that the Liquor of the milky Vessels is nothing but a frothy *Lympha*, which is filtered thro' the Glandules of the Intestines, and carried thro' the Arteries.

Here are the Arguments they bring to prove, that the *Chyle* passeth into the Meseraick Veins. 1st. They say, since the Umbilical Veins carry the Nourishment to the *Fetus*, and that the Meseraick Veins are derived from the same Trunk, they will serve also to convey the *Chyle* to the Liver. 2d. The Veins do not only serve to bring back the Blood, but also every Thing else that may enter into their Orifices, so that one may have reason to think that the Meseraick

Veins do also receive the *Chyle* into themselves; besides the Blood which they bring back; that though they have no Let or Passage into the Intestins, we do not thence conclude, that they are incapable of receiving the *Chyle*. Do we not find by Experience, that the Veins betwixt the Ribs, which are terminated in the *Pleura* often suck up the Corruption and Secrecy in an *Empyema*. 3d. The Trunk of the *Vena Porta*, and the *Meseraick* Veins is so big and large towards the *Duodenum*, that it is capable of receiving three or four times more Blood than what cometh in the Arteries. 4th. Here is one of their Experiments, if one maketh a Ligature on the *Mesenterick* ^{Trunk of the} *Liver*. series of a Living Dog, and afterwards sew up the wound again in the Belly, soon after one findeth the series empty, and the *Meseraick* Veins full of *Chyle*; the Liquor then passeth from the Intestins or Guts, to the *Meseraick* Veins, since it cannot pass into the series by reason of the Ligature.

To answer all these Arguments we say. 1st. That there are no Milky Vessels, or *Vena Lactea* in Birds, the *Meseraick* Veins are otherwise disposed in Birds, than they are in Four-footed Beasts; at least, if the Experiment which some mention is true, which is to make a Ligature on the Intestine of a Goose, and to blow into the *Meseraick* Veins, we are assured, that the Wind passeth into the *Vena Porta*, which never opens in other Animals, since this Experiment hath been often tried, we must not be surpris'd, that the *Meseraick* Veins have another particular use in Birds. 2d. Where it is said, that the *Vena Lactea* is too small to carry all the *Chyle*, we must observe, that of all the Nourishment we take, perhaps there is not the tenth part of it turn'd into *Chyle*, all the rest goeth into Excrements. 3d. The *Chyle* doth not pass all at once from the Stomach into the Intestines, but at several times by a Motion slow enough, so that the small quantity of *Chyle*, which runneth very gently into the Guts, is proportion'd to the smallness of the *Vena Lactea*. 4th. We know not what a frothy Dew is, which is full of Spirits, and which as they pretend, causeth the whiteness of the Milky Vessels; nothing passeth into these Pipes but *Lympha* or *Chyle*: It is well known that the *Chyle*

Brills Anatom.
rus.

Swam-
merdam.

is white before it enters into the *Vena Lactea*, therefore it hath no need of this spirituous Dew to make it ferment, since the *Chyle* in the Guts is not frothy at all, and that it retaineth its whiteness a long Time in a dead Animal, provided the *Lympha* be mix'd with it. In fine, if the *Chyle* of the *Canalis Thoracicus* is more serous, it is not because it hath lost its Froth, for the *Chyle* is never frothy; but it is, because being mix'd with the *Lympha*, which is plentifully convey'd to the *Canalis Thoracicus*, it is thoroughly washed and dissolved, as it riseth up thither. 5th. It is not true, that the *Vena Lactea* never contains any Thing but the *Lympha*. which cometh from the Glandules of the Intestines; nothing can give the white Colour to the *Lympha* of the Guts but the *Chyle* that is mixed with it. 6th. The Glandules of the Guts are not placed at the Orifice of the *Vena Lactea*, but always on the other side over against it. 7th. they will have the small whitish Particles, which they have observ'd in the Blood of the *Mesenterick Veins* (wreathed, or twisted round like so many little Threads) to be *Chyle*; why should not that Liquor be call'd *Chyle* which floweth into the *Vena Lactea*, even when it passeth into the Guts? Is it not a Liquor much whiter than those little Threads which they observ'd in the Blood of the *Mesenterick Veins*? Besides what they saw was not *Lympha*, but *Chyle*.

We have already observ'd, that all the *Vena Lactea* are at the same time *Lymphatick* Vessels; for even when there is no *Chyle* passeth, the *Lympha* continually passeth thither. This Liquor proceedeth from the Glandules of the Mouth, the Stomach and Guts.

As to the Food of the Chick which passeth through the *Umbilical Veins*; what consequence can be drawn thence for the *Mesenterick Veins*? For these Veins have no Branches or Ramifications in the *Chyle*, but the Roots of the *Umbilical Veins* which are mingled with the Yelk, and White of the Egg. they say that the *Vena Umbilicalis* in Animals is appointed for the conveying of this milky Liquor which is mix'd with the Blood of the *Fetus*, and that so the *Mesenterick Veins* may serve also to carry the *Chyle*, since they are deriv'd from the same Trunk.

this we can make no other Answer than to repeat what we said before, that the *Meseraick* Veins do not any wise open into the Guts of Animals as do into those of Birds: Some have imagin'd also, Marchetti, that the *Vena Lactea* were terminated in the *Plexus Mesentericus*; but Experience hath shew'd us, that it is otherwise. For the first *Vena Lactea* do all end in the Glandules of the *Mesentery*, where their Branches are insensibly lost.

The Windings of the *Vena Lactea* serve to moderate the Course of the *Chyle*, and to retard its Motion, to prevent its more immediate passage into the *Canalis Thoracicus*, where it hath a more rapid course.

The *Peristaltick* Motion of the Guts pusheth the *Chyle* forward into the *Vena Lactea*, even to the *Receptaculum* and the *Valves* of the *Canalis Thoracicus* prevent its returning back again upon making of a *Ligature* on the *Canalis Thoracicus* for the stopping of the *Chyle*, the *Valves* render it all *Varicous*. As the *Valves* are disposed to give a free passage to this *Liquor*, but not to let it return when once the *Contraction* of the *Intestine* ceaseth, the *Chyle* cannot return into the Guts; but as soon as that Motion is restor'd, the *Liquor* must necessarily advance, because the *Chyle* which floweth there is like a *Wedge* which presseth it forward into the *Conduit* or *Pipe*.

After the *Chyle* is passed into the Glandules of the *Mesentery*, and that they are all full of it, their *Fibres* by a certain Spring squeeze out this *Liquor*, and press it into the *Secondary Lacteous Vessels* or *Veins*, which pour it into the *Receptaculum*. The Motion of the *Diaphragma*, and that of the *Arteries* do effectually promote the mounting, or rising up of the *Chyle*, while these Parts are always pressing on the *Receptaculum*, and the *Canalis Thoracicus*. The *Valves* which are here and there plac'd in the *Canalis*, do all much facilitate the mounting of the *Chyle*, being so many stops or degrees, to support the *Chyle*, and to hinder its flowing back. All the *Chyle* at length passeth into the *Vena Subclavicularis*, where the *Canalis Thoracicus* emptieth it self thus, by mixing it with the *Blood*, it maketh it more *Watery*, as plainly appeareth in the bleeding of any one four or

or five times after he hath Eat; there is always be seen an abundance of Chyle Swimming on the Surface of it, because all of it hath then passed into the Blood. It is true that this white Liquor which one findeth then in the Blood doth not always proceed from the Blood, for sometimes it is an effect of its Corruption, as it appears in those who are sick of Malignant Fevers, whose Blood, when drawn, doth often look like Milk. Some also pretend that Milk Circulates with the Blood; for this they relate a very curious Observation in Bleeding of a Nurse, who was sick of a Fever, they drew from her Veins pure Milk, which presently coagulated in Porringers. This Coagulation sheweth evidently that it was no *Pituita* or Flegm, since that is always Liquid, and never coagulates or curdles.

Just there where the *Canalis Thoracicus* is inserted into the *V. Sub-clavicularis*, there is a certain Vein which is half circular, whence being thus formed or disposed, it neither checketh the Course of Chyle, nor that of the Blood, which returns to the Heart by the *Axillaris* and the *Jugularis*. The Chyle never entereth the Heart before it be well diluted with good store of *Lympha* from the *Lymphatick* Vessels of the lower Parts of the Belly, and of the Bowels or *Viscera* in the Breast; therefore Chyle is always more fluid and transparent in the *Canalis Thoracicus*, than in the Milky Vessels of the Veins, as we have already observ'd.

C H A P. XIII.

Of the Blood and the Lympha.

hath always hitherto been suppos'd, that the parts of the Body were nourished purely by the Blood; but if we reflect, that it is the *Lympha* that beareth this nourishment, and not the Red part of the Blood, and that there is alway much more *Lympha* Blood, perhaps we may be easily perswaded, that the Chyle is not turn'd into Blood, but that on the contrary the greatest part of it goeth to the concoction of the *Succus Nutritius* or nourishing Juice: This is to say, that all the Chyle, in a manner, turns into Lympha. The Blood seemeth to be an Homogeneous Liquor, tho' yet it consisteth of two parts, one of one is that serosity, which *Hippocrates* calleth the white Blood, and which in these times is called *Lympha*, or the Dew of the Blood.

At this point the Antients and Moderns do very much disagree, since they both equally admit of these two parts in the Blood: The difference which is yet between them consists in this, that the first have look'd upon the serosity of the Blood, as a watery saltish humor, which is only separated from it as an Excrement, and no ways filtrated or strain'd thro' any particular Organs; whereas the other (that is) the Moderns do not esteem it as an Excrement, but as a part that is proper for the Nourishing of all the parts of the Body.

These are the Arguments they bring for the Confirmation and Proof of this their Opinion. First the Lympha is mix'd with the Blood, in order to be conveyed to all the Parts of the Body, it returneth afterwards to the Heart, either with the Blood, or a part, by means of the Lymphatick Vessels. Secondly, the Lympha being once Extravasated in any considerable Cavity of the Body, as in the Breast or Belly, the parts of the Body grow Lean for want of their usual Nourishment; and so it is in

in those Diseases which are called the *Hydrocephalus* and the *Ascites*.

Some are apt to distinguish the Serosity from *Lympha*, because the *Lympha* seemeth to be a Liqueur that may serve for Nourishment, whereas, on the other side, the Serosity is an unprofitable Excrement that is good for nothing; but this is an Imaginary difference, it is the same Liquor which is mix'd with the Blood, in those Vessels which contain Blood, and which is separated from it, when it is in the Lymphatick Vessels. It is an evident Sign that Serosity differs not at all from the *Lympha*, since it hath the same qualities, it contains in it much Gelly also, as the *Lympha* doth, it thickens over time, and hath the same smell and colour.

The red part of the Blood containeth also much Gelly in it, which is easily separated from it by filtering the coagulated Blood in hot water, or that which is boiled a little, for after you have filtrated the Liquor, and Evaporated it, there remains at the bottom of the Vessel a Clammy, and Mucilaginous sediment, and what is there besides, is nothing but a red Powder which hath no more the same bulk nor weight.

It is this Mucilage, which being mix'd with the red part of the Blood, maketh the Consistence of the Union of it, it is this which maketh the Blood coagulate more or less easily, according as there is more or less of it; it is this which produceth the little Skins or Membranes on the Blood, which when poured into water, that is first hot, and afterwards suffered to cool again; because the hot Water dissolving the Glewy and Clammy part of it, is afterwards separated from the red part of it, and by losing motion upon the Water's growing cold again, the Particles being United to each other, do form certain little Filaments, and thin small Membranes: So if you beat the Blood when it is hot, several fine Threads are found, just as it is in beating of Cream, the more Branchie Particles of the Milk, by being intangled together, do make Butter; but we must not Imagine that there are any such thing as Fibres in the Blood, for if the Blood was really any thing *Fibrous*, it would, by no means, pass into the Capillaries.

so might produce great Obstructions. Besides, there are no Fibres in the Blood, one would easily discover them by the help of the Microscope.

It is an Error to imagine (with *Harvey*) that this thick Gelly, which swimmeth on the Superficies of Coagulated Blood, doth any way differ from the Serum, and that it is more perfected than the other parts of the Blood. He saith also, That the Superficies of the Blood is more red, and of a more Vermilion Colour, than that which is in the bottom of the Porringer, which is of a dark and brown Red, as appeareth in Coagulated Blood, whose Upper part is Redder, and Under part more Blackish. This diversity of Colours doth not any ways shew, that there are two sorts of Substances in the Blood, the one which is more pure and more subtle, the other more earthly or more gross; but this diversity of Colour dependeth on the Action of the Air, which toucheth the Blood, and modiifieth the Superficies of it, so, as by the Light to make it look Red. Thus the Blood of the Veins which is blackish, is no longer expos'd to the Air, but there is form'd on it a little Coat or Membrane of a Scarlet Colour. If you but turn the Blood in the Porringer or Dish, this black Colour is soon chang'd into a fine Red, by being expos'd to the Air. The same thing happeneth to the Blood of the Arteries, when it is Coagulated, the Superficies of it only which the Air toucheth on, remaineth Red, the other part of it continues always blackish.

To solve or explain this *Phenomenon*, we shall suppose that the Red part of the Blood is composed of several little Globes or Bowls, which turn about their own Center.

As soon as the Blood is out of the Vessels, and that it begins to Coagulate, these little Bowls lose their motion, by sinking or falling down flat upon each other; but those which are on the Superficies of the Blood, which is exposed to the Air, being not so much pressed on, do yet retain their round Figure, and the light in penetrating them, after several reflections and refractions, is reflected back on our Eyes, and thence proceedeth the Red colour of it. As the

Globular parts of the Blood, which are undermed are more pressed together than those above, 'tis true they reflect the light strong enough, but yet they absorb also much of it; whence proceeds those shadows which make the Blood seem to be of an obscure Red.

By this we see the reason why in handling a clod of Blood betwixt ones Fingers, and dividing it into several pieces, it cometh to have a fine Red, because by this handling of it, many of the Globular parts of it, which were United close to each other, and which did in a manner hide each other, being now as it were Unglued or separated, and plac'd all side ways, they form a Superficies which the light penetrates, on all sides. We see the same thing by looking on the Blood in a Glass Pipe, with a Microscope; all of it seemeth Red, because the little Bowls of Globular parts of it, in so small a space, are but few, and as they still retain their round Figure, the light easily passeth thro' them. But if in these little Glass Pipes one vieweth the Blood which is yet hot, one may see their little Bowl swimming on a transparent Liquor, but as soon as the Blood is grown cold, and is coagulated, these little Globular Particles join each other, and fall flat down, and this is that which coagulates the Blood. As to the *Lympha*, the Parts of it being infinitely more delicate, and entirely, as it were, Humouring the Motion of the subtle Matter, it remaineth more fluid by swimming on the Blood; much exceeds the red part in quantity; for Example for one part of Blood, there will be ten of *Lympha*.

There are in the Blood, *Chyle*, and in Milk certain fat Particles, and these compose the Globular Part or Bowls, in that part of the Blood which is red; the thicker part of the *Lympha* serveth for Nourishment as we have said before; and as for the Watery and Saltish Part of the *Lympha*, that flows off with the Urine.

Willis.

Some look on the *Lympha* as the remainder of the nervous Juice. 1st. Say they, all the Glandules have more Nerves than they need for their Sensation. 2^d. Plentiful Salivations which last a long time, dry up all the *Genus Nervosum*. 3^d. If the Spittle happen

happens to dry up all at once, Trembling of the
 parts, Convulsions. and many other ill Accidents
 proceed upon it, which depend on the Indisposition
 of the Nerves. 4th. It is observ'd, that any com-
 pression on the *Glandules* of the Groyne, produceth
 Tremblings in the Head, and Convulsions. 5th. Vi-
 olent Passions cause great Alterations in the Milk of
 the Nipples. 6th. When one maketh a Ligature on the
Arteriae Recurrentes, the Spittle groweth copious or
 plentiful from the *succus Nervosus* being cast up.
 7th. The *Lympha* continueth its motion much lon-
 ger than the Blood, so that if one maketh a Ligature
 on the *Lymphatick* Vessels a little after the Death of
 an Animal, they swell very much; therefore their
 liquor must be deriv'd from some other Source or
 spring, than that of the Blood.

All these Difficulties are soon answer'd by saying at
 first; That the being of this Nervous Juice could ne-
 ver yet be demonstrated. Secondly, It is true, that
 the *Glandules* have more Nerves than Arteries, but it
 is not because of the Nervous Juice, since there is no
 liquor at all in the Nerves, it is for other particular
 reasons, which we shall afterwards explain. 3^{dly}, We
 confess, that a long Salivation drieth up, and much
 weakeneth the Nerves; and that when it is stopped
 at once, or on a sudden, sad Accidents, as Con-
 vulsions, Tremblings, and such like, do commonly
 follow. But these *Phenomena's* may be solved very
 easily without recurring to the Nervous Juice. A
 plentiful and copious Salivation drieth up the Nerves
 of the Brain too, because these Parts as all others
 are nourish'd with the *Lympha*. The Suppression of
 the Spittle causeth sad Accidents, because by coming
 up, it irritateth and disturbs all the System of the
 Nerves. 4^{thly}, The compression or squeezing toge-
 ther of the *Glandules* in the Groyne may produce se-
 veral Accidents, which depend purely on the Nerves,
 because these *Glandules* have a Communication with
 the Nerves, and the Convulsion which beginneth in
 the end of a Nerve, which is terminated in any part,
 and which is occasion'd by Compression; This Con-
 pulsive Motion passeth presently even to the Brain.
 5^{thly}, If the Milk is chang'd or alter'd by our Passi-
 ons, it is not from the Nervous Juice which is in the

Nerves of the Breast; but it is, because in violent Passions the Course of the Blood and other nourishing Liquors is disordered, which proceeds from the extraordinary Motion of the Muscles; this is that which causeth the Alteration of the Milk in the Breast. 6thly, By making a Ligature on the *Nervi Recurrentes* the Salivation becometh more copious, not because the Course of the Nervous Juice in the Nerves is stopped, and that so there passeth more of it into the Glandules of the Mouth by other Branches from the same Trunk; but it is because in making a Ligature on these Nerves, they are thereby contracted in pressing the Veins together, so that the Course of the *Lympha* being hindered, it must necessarily be strained or filtrated in a greater quantity. In fine, if the Motion of the *Lympha* continues still for some time after Death, this ariseth not from the Mixture of the Nervous Juice, but it proceedeth rather from the Spring of the nervous *Fibres* of the *Lymphatick* Vessels, which lasteth for sometime after Death: For tho' this Spring is too weak after Death in the Heart and Arteries to make the Blood Circulate, yet that of the *Lymphatick* Vessels is sufficient to make the *Lympha* move, because that is of a more Liquid Substance than Blood.

The *Lympha*, as soon as ever it hath been filtrated thro' the Glandules, is presently mix'd with the Blood, and the remaining part of it, which could not serve for the Nourishment of the Parts, returns to the Heart by the *Lymphatick* Vessels, and by the Veins: it is always more Watery, because all the Nourishing Particles which it had remains behind in the Blood. The Texture of the Parts, in order to nourish them. The reason why all the *Lympha* returneth not by the *Lymphatick* Vessels is this, that there is always a part of it which is not separated at all, but remains still with the Blood, that passeth into the Veins. for that part of it which is separated, it cannot pass into the Veins, because their Orifice is only proportion'd to the receiving of the Blood; therefore it must pass into the *Lymphatick* Vessels, whose Orifices are accordingly disposed to receive it.

As to Milk, we must not imagine, that it is made by the Blood, as it passeth into the Glandules of the Breast.

Breast; but it is made before, and only wants a strainer to separate it from the Blood, which is perfectly accomplish'd by the *Glandules* of the Breast; for Milk is nothing else but *Chyle* or *Lympha* strain'd thro' these *Glandules*, which by their particular structure are fitted for the Work. The particles of Milk have a closer Union one with another than the Blood hath, and are not so easily separated, and this is the Reason, why Milk doth not coagulate so soon as the Blood, unless when the Particles of it are any ways agitated or disturbed, by which the Serosity may be separated from it, and then it coagulates as the Blood doth.

There are two Difficulties to be clear'd here, which may dispose one to think that Milk is not made by the *Chyle*, but by the Blood. The first is, that Milk is at first serous and watery, and doth not thicken till afterwards, which sheweth that the Milk is not made by a simple filtrating or straining of the *Chyle* in the *Glandules* of the Breast, but by the Blood, which passeth into these *Glandules*, and is there perfected by way of Concoction. The other Difficulty which they propose is this: They say, that Milk, which is arriv'd to its last Perfection, is always thicker than the *Chyle* in the *Vena Lactea*, or in the *Cannula Thoracicus*, and even thicker than that *Chyle* which is in the Blood. In answer to what is here objected, we shall observe, that the Pipes and *Glandules* of the Breasts are at first very narrow and strait, especially in young Women, who never have had any Children; these Pipes as they grow larger by degrees, or by little and little only, they take in nothing at first but the thinner and more fluid part of the *Chyle*; but after several Circulations frequently repeated, the Texture of the *Glandules* in the Breast is loosen'd, their Pipes are opened, and then they are capable of straining all the *Chyle*, thus the Milk becometh thicker. In fine, the Milk is thicker than the *Chyle*, it is by reason of the stay that it maketh in the Breasts; and so the more serous *Lympha* which hath been filtrated with it is taken up again by the Veins, in order to circulate fresh.

Let us now examine how Sanguification is performed, or how the Blood is made.

All the Ancients in a manner have attributed this Work or Office to the Liver. If it is the Liver, that maketh the Blood (as they would have it) let them answer me this Question, how cometh there to be Blood in an Egg, and in a Chick, before there is any Liver formed there. The Livers of most Fish are either white or green, tho' their Blood is red; for according to their Hypothesis, it must be the Liver that giveth that Tincture to the Blood. In fine, we demand of them, why the Liver of a Chick is so pale? And why doth it not come red till afterwards? Let them explain, why in such as are beheaded when all the Blood is lost, the Liver groweth so pale. Is it that it loseth, so its natural Complexion or Colour, we see also, that if one syringe the Liver, it loseth its red Colour. From all these Reasons it plainly appeareth, that it is not the Liver which maketh the Blood. But here are stronger Reasons also which must make them confess in spite of themselves that it is the Blood, which makes the Liver, and not the Liver that makes the Blood; for since they believe, that the Liver is only a *Parenchyma*, or a Mass of Coagulated Blood, there must of necessity be Blood before it can be said to be gathered together about the Vessels of the Liver.

The *Chyle* or nourishing Juice which the *Fœtus* receiveth from the Mother, passeth not at all into the Liver; but it passeth immediately from the *Vena Umbilicalis*, and the hollow Part of the *Vena Porta* into the veiny Channel into the Branches of the *Vena Cavalis*, and yet without ever passing into the Liver it becometh Blood, it is not then the Liver that maketh the Blood; and so we must say of the Heart.

1. There appeareth Blood in a Chick, about the Extremities, or Ends of the Umbilical Vessels, before there appeareth any in the *Punctum Salientis*.
- 2d. The Heart which is a Muscle, cannot any ways contribute to make Blood, but only to receive it, and drive it afterwards by means of its strong Contractions into all the Parts of the Body.
- 3d. Tho' the Heart receiveth all the Blood and all the *Chyle*, in order to distribute it; it doth not therefore make the Blood, since it must first receive, before it drives it to the Parts.

The Heart is to be looked on as a fulling Pump

ump, which drives on the Blood, in order to distribute it thro' the whole Body. 4th. There is no such difference betwixt the Blood of the Veins, and that in the Arteries. It hath been said, that the Blood in the Veins, which is thick, black and gross, became red, and of a *Vermillion* Colour upon its leaving the Heart; but it receiveth not this fine Colour at the Heart, but rather in the Lungs, as we shall make it appear.

As for they who maintain, that the Blood hath a power of changing the *Chyle*, because in dividing its particles, it disposeth and rangeth them so, as to make Blood, one may say that this Hypothesis is not entirely true; for it is not enough in this case, that the Blood acts on the *Chyle*, but the Action of the Organs must also contribute thereto.

Many are apt to assert, that the *Chyle* is turned into Blood by Fermentation. We have already shew'd that these Liquors are not fit to Ferment, besides Ferments do not any ways alter the nature of those Things which they Ferment. For Example, take the Lees of Wine to put any Body into a Fermentation, we do not see, that it changeth this Body into Lees. If they still urge, that Ferments have the power to change those Bodies which they put into a Fermentation, how cometh it to pass, that *Must* or new Wine, (which is certainly a Ferment) doth not turn Water into Wine? For when the Juice of the Grape becometh Wine by Fermentation, one Body doth not make any change on the other, but it is the same Liquor which is purified. Let us then rather say, that Sanguification is only a Purification of the *Chyle*, not only by clearing it self in the *Glandules*, from many gross Particles, but also by passing thro' the Lungs, where the Air giveth it a new Modification. Not to trouble our selves with more Particulars on this Subject, that which seemeth most probable is, that the *Chyle* in passing thro' the *Glandules* is filtrated, or rather turn'd into many Substances; one whereof is clammy like Gelly, another is liquid like Water, there is also another which is fat and sulphurous. But the *Chyle* is not clear'd of its fat Part without many precedent Circulations, for it remaineth a long while in the Vessels under its

first Form. As soon as these Saline, Sulphurous Particles come to pass thro' the Lungs, the elastick force of the Air fashioneth them into a round Figure; and after they have several times cross'd thro' the little Bladders of the Lungs, they are all chang'd into little Bladders, which are strong enough to retain their round Figure, and to turn about their Center. In fine, it is the Mass or Heap of all those little Globular Parts, which gives the Blood that fine scarlet Colour.

That which disposeth us to believe, That this sulphurous Part receiveth this Modification in the Lungs is this; That the Blood which floweth out thence is always trothy, and of a Vermillion Colour; but one invincible Argument of the redness of the Blood's proceeding from these small Globular Parts is this, that you may see them turn round in a Christalline Liquor by observing the Blood still hot with a Microscope as we have said before. This Motion lasteth as long as the Blood remaineth fluid, but as soon as it is coagulated, these Globular Parts cease from turning about; they come close to each other, and lose their round Figure, which maketh the Blood seem black. This is the Reason why the Blood in the Veins is never so red as that in the Arteries, because the Cavities of these little Bowls being no longer stretch'd, as was in the Lungs by the Spring of the Air, which is now grown weak, they wither; but as soon as even the Blood returneth to the Lungs, let them never be so wither'd and intangl'd with each other, they presently separate themselves, and by a Circular Motion which the Spring of the Air giveth them, they swell, and return to their first Dimensions; and this is that which makes the Blood look so red by the Refraction of the Light which passeth thro' them.

The redness and liquidity of the Blood then, proceed from those small Globular Parts, and their Motion. Yet we must not imagine, that these little Bowls have any real redness in them, tho' they seem red, if you but view each of them apart, they are transparent and clear as Christal, they are not therefore red in themselves, but being many of them together the light which passeth thro' them by being re-

fract

ted under several Angles, occasioneth this red-
ness, even as in those drops of Water which com-
pose the Rain-Bow, when the light passeth thro'
them.

Whilst all the Humours thus roul thro' the whole
Body, and the fattest, and more Sulphurous Particles
among them are turned into little Bowls, the remainder
of the *Chyle*, by being much circulated, is dissolved
and melts, and the Air which it receiveth in passing
thro' the Lungs, turns it into a substance, that hath
not so much Motion, nor Activity as those Particles
had, which serv'd to constitute the red Part of the
Blood. Yet this Liquor is highly necessary, since
without it there would be no Nourishment, as we
have shew'd before.

We have said, that the Parts were nourished by the
Lympha, but we have not yet determin'd after what
manner they are nourish'd by it. They say, that all
the little Bowls of the Blood which have a very rapid
Motion, unite to themselves all the Gelly that is in
the Blood; this Gelly is melted by the rubbing of
the Bowls against it, thence it becometh more liquid,
and fitter to penetrate the Bladdery Texture of the
Parts, where it is also pushed on a fresh, by the
Motion of these Bowls which force it on like the
pucker in a Pump, in order to make it enter still far-
ther.

The Motion of the *Lympha* is like that of the
Blood from the Heart to the Extremities, and from
the Extremities to the Heart. The Blood first
spreads it thro' the Arteries, afterwards it returneth
by the Veins and by the *Lymphatick* Vessels, which
are certain transparent Pipes or Channels, and so
fine, that with the least touch of the Finger, they
presently break and vanish altogether, because the
Lympha runs out of them.

Some will have it, that these Pipes have two Mem-
branes, in which the *Lympha* (as they pretend) is car-
ried from the Center to the Circumference of the
Body; but these two Membranes have never yet
been discover'd, nor the space betwixt them, for the
carrying of this *Lympha* from the Center of the Body
to the Circumference of it. The *Lympha* that is in
these Pipes passeth not to the Extremities, but on the
contrary,

Bills.

contrary, it returneth from thence as it evidently
seen by Ligatures and Injections ; for since they
betwixt the Ligatures and the Extremities, it is an
evident sign, that the *Lympha* moveth not as they pre-
tend, but that on the contrary, it returneth from the
Extremities to the Heart. And when they con-
fidently deny the *Valves* of the *Lymphatick* Vessels,
they contradict common Experience, which
sheweth, that an Injection enters not without
great difficulty on that side where the *Valves* are
clos'd or shut up.

After all that hath been said about the *Lympha*,
we see that the use of it is absolutely necessary in an
Animal, it is this which furnisheth the *Saliva* or Spi-
tle, which is the Dissolvent of the Stomach, it is
this which makes the *Chyle* more fluid, or to run
better : It is this in fine, which constituteth the great-
est part of the Blood, for take away the *Lympha*,
and the Mass of the Blood will be reduced to a
small Substance. It nourisheth and quickeneth the
Parts, with that fat Gelly we mention'd before.
Moreover after several Circulations it leaveth in
Saline and Sulphurous Particles in the Blood, and
its Gelly in the lesser Pores of the Bladders of the
Parts, and afterwards it becometh as clear and trans-
parent as it was at first, without losing any Thing
of its dissolving Vertue or Power, so that it is able to
dissolve fresh Food.

CHAP. XIV.

the Separation of the Urine in the Kidnies.

It hath always been said, that the Urine was an Excrement of the Blood, but it ought to be rather the Excrement of the *Lympha*, for, wherever there is any Serosity, there are also Excrements; it is to say, Waterish and Saltish Particles, which have been separated from the *Chyle* and *Lympha* which are partly evaporated thro' the Pores, and partly carried off with the Urine. By that we already perceive, that the Urine is not so much the Excrement of the first, second or third Concoction, as the remainder of all the Digestions together.

That which perswadeth us, that the Urine is rather the Excrement of the *Lympha*, than of the Blood

1st. That there is much more *Lympha* in the Blood, than there is red Parts, as hath been shew'd. 2^d. The Particles of the red Parts of the Blood in their natural state seem not disposed to be easily dissolv'd for furnishing Matter for Urine. 3^d. So great a quantity of Urine must needs proceed from the *Lympha*, and not from the red part of the Blood, because there is always more *Lympha* than Blood: The Urine then is nothing else, but the Watery saltish and Sulphurous part of the *Lympha*, filtrated & strain'd thro' the Kidnies. They who first look'd on the Urine as an Excrement of the second Concoction, say, that the Salt Taste and yellow Colour of it proceed from the *Bile*; but to those, who yet in these Times talk much to the same purpose, I propose this Question, why is the *Bile* separated in the Liver, and not in the Kidnies? If Nature had design'd, that the *Bile* should be mix'd with the Urine, to communicate this yellow Tincture to it, she would not have separated it in the Liver, but it would have been strain'd in the Kidnies. 2^d. As to the Taste of the Urine, that proceedeth not from the

Bile

Bile, since the *Bile* containeth no Salt like that of *Urine*. 3d. If it were true, that the *Urine* receiveth its Tincture from the *Bile*, it would require much of it for that purpose, and the *Urine* would also be bitter, which it never is, for when one drinketh well, the *Urine* hath no bitterness at all in it.

Willis,
Swall.

Some pretend, that all the *Urine* is not strain'd thro' the *Kidnies*, but that a good part of it passeth immediately from the *Stomach* and the *Guts*, thro' the *Bladder*; they say, that when one drinketh much, one presently maketh *Water*, which would never happen so soon, if the *Drink* did circulate first in order to be strain'd in the *Kidnies*, because this would be too great, or too long a course for it; let us be true, that one maketh much *Water* after one hath drunk a great deal, which must purely proceed from the great quantity of *Liquor* which mixeth with the *Blood*, and is presently carried to the *Kidnies*.

The *Ancients* soon explain'd these *Filtrations*, by supposing, that the *Kidnies*, as well as other *Glandules* had a certain attractive *Vertue*, and that so the *Kidnies* separated the *Urine* from the *Blood*. Most of the *Moderns* will have it, that there is a particular *Ferment* there which serveth to precipitate the *Urine*, by which it is the better dispos'd to be strain'd thro' the *Glandules*. But without supposing any such *Ferment*, let us consider, and view only the structure of this part, which consisteth of *Glandules* and *Excretory Pipes*, which are very fit and proper for the separating of *Urine*.

M^r. Mal-
pighi

There is an able *Author*, who proposeth a doubt here which is reasonable enough; He asketh, whether the *Kidnies* sometime separate *Corruption*; or Matter, for if it be true (as they pretend) that the structure alone of the *Kidnies* is sufficient for the Separation of the *Urine*, this strainer must needs change its Figure as oft as any strange Matter is mix'd with the *Blood* in order to separate, or strain it in the *Kidnies*. To solve this difficulty we say, that if in some *Disease* *Corruption* and other *Foreign Matters* sometime flow off with the *Urine*, this proceedeth from the Relaxation of the *Pipes* in the *Kidnies*, and as the Holes of this strainer are thereby enlarg'd, those Impurities

ities may easily pass thro' them, but the Blood never pass there, because the Particles of it are rough and uneven to slide or slip thro' these les.

Some demand why all the Urine is not separated the Kidneys the first time that the Blood passeth Mr. Bo-

re? Some answer here, that all the Blood is not ried presently into the Kidneys, but only the eatest part of it, and that therefore the Urine is se- rated at several times in the Kidneys, and not all once. But this is not solving a *Phenomenon*, since e Blood which is carried by the emulgent Arteries, d returneth by the Veins, is yet all charg'd with rine, they should rather say, that one part of the ood, which goeth to the Kidneys, is for its nourish- ent, and that the rest of the Serous part returneth y the Veins. Besides the *Lympha* being join'd with e other Particles of the Blood, it cannot be all at nce strain'd into the Kidneys, but the Blood must rry it in at several times, that being thus loosened, d as it were set at liberty, it may be the better fil- ated in the Glandules of the Kidneys. Now the epeated motions of the *Diaphragme* and Muscles of e Belly, cannot any wise contribute to this Filtra- on, because the Veins are of too firm and too com- act a Substance to be any ways squeez'd or pres- d by these Parts.

This straining of the Urine produceth purely from an impulsive motion, that is to say, from the force nly with which the Blood is driven from the Heart nto the Emulgent Artery: This stroak of that Pump is sufficient for the straining of the Serosity n the Kidneys. To this also we add the beating f the Arteries, for as they dilate themselves upon ery impulse of the Blood, they strike on the Gland- ules and excretory Pipes, which forceth the Urine hat is there to flow into the Bason. When it is rained it descends into the Ureters, and from thence nto the Bladder, where it is reserved till there is enough to irritate the Fibres of this part, and so ob- lige it to evacuate it self.

Some have thought that Urine, by vertue of its own weight, falls drop by drop into the Bladder; but we cannot conceive how Urine can descend into the

the Ureters, unless these Pipes have a Peristaltick progressive motion to push on the Drops of the Liquor, even into the Bladder; their Motion must needs be very considerable, since they often expel Sand and indifferent big Stones, which would never have descended there without a strong contraction of these Pipes, which occasioneth cruel Pains; and when the Sand or little Stones are stop'd in the Descent, Death soon follows; Weakness also, and the bigness of the Stones do often deprive the Ureters of their Motion.

No one would doubt of this Peristaltick motion of the Ureters, did they reflect only on what happens in Birds. Their Kidneys are very large, and some what long, consisting of several small Glandulous Grains; they are seated on both sides of the backbone, over against the *Aorta*, that descends into the Cavity of the *Os Ilium*. The Ureters, which are big enough, come out before, or in the fore-part, and descend in a strait line, to the *Cloaca*, or lower part of the *Intestinum Rectum*, or streight Gut, into which they are opened. By these Pipes the Urine descends from the Kidnies into this Cavity.

*The Urine
of Birds.*

Birds or Fowls make but little Water, because they Drink but little, nay, some of them do not drink at all, as the Eagle. The Urine in them hath no other Basen than the *Intestinum Rectum*, therefore it is presently mix'd with the Excrements; but that their Liquor is much different from that of other Animals, it is thick, and full of a sediment or very white head of Mortar, which being expos'd to the Air, soon thickens, and is dried up, when all the moisture of it is Evaporated, there remains nothing but a little Crust, which crumbleth into dust. This matter is not only in the *Rectum Intestinum*, but there is much of it also in the Ureters, where it looks like diluted Chalk.

This Cement or Mortar is so hard in some Birds when it is dry, that after it hath been expos'd to the Air a while, it becometh a perfect Stone; this kind of Mastick is of great use in some Fowl. There is a little Island in *Scotland*, which is called the *Bass*; it is in the Main Sea, yet near enough to the Shoar, but inaccessible, there's no getting up it but by a Crane.

e. It is a very steep and High Rock, which
 hath a Retreat to abundance of Wild Geese and
 Fowls, which come there to build their Nests
 in the Months of *May* and *June*: The
 Mountain is so covered with them, that one cannot
 go without squashing of them. They darken the
 Air by their Flight. All the cliffs and holes in the
 Rock are full of Nests. The Lord of this little Isle
 hath a good yearly Revenue from it by selling of
 Eggs and Fowls.

This Island at a distance seemeth to be all white
 as if it were Chalk, yet the Rock is blackish. This
 is only appeareth white, from a brittle whitish
 Crust which covers it all over, just as if it were all
 covered. This consistence of this Crust is no big-
 ger than an Egg-shell, some of these Geese make no
 use at all, and these only lay but one Egg, which
 is fastened to the Rock. It is purely fastned by the
 Cement we mentioned before; for with the Egg
 cometh out much of it, which fastneth it to
 the Rock. Sometime after the Egg sticks so fast, that
 one can hardly pull it off. This small and curious
 Observation well sheweth how necessary the motion of
 the Ureters is in these Fowls, for this thick Urine, or
 rather this Cement, could never descend from the
 Ureters into the *Intestinum Rectum* without strong
 contractions.

After that the Urine hath continued for some time
 in the Bladder, the plenty of it, or rather its Acridi-
 ty strongly irritates the fleshy Fibres, this irrita-
 tion determineth the Spirits to flow into these Fibres,
 so that this Muscle swelleth and groweth stiff, and by
 strong Contraction it overpowers the Sphincter of
 the Bladder, thus the Sphincter is loosened, and the
 Urine floweth out. This Compression is promoted
 by the Muscles of the Belly, especially the right
 pyramidal Muscles, all these together do much
 facilitate the passage of the Urine. By keeping one's
 Urine too long, there sometimes followeth a total
 compression of it, because the fleshy Fibres of the
 Bladder lose their spring by too great a tension, so
 that they cannot close themselves again to drive out
 the Urine. There are not three kinds of Fibres in
 the fleshy Membrane of the Bladder, as some have
 said,

said, there are only Fibres which go longways, that are Circular, or that go a-cross.

If one turneth the Bladder, and filleth it with water, the water is of its self filtrated thro' the Membranes of it by little and little, even running out it as if it were bored with little holes; but which is more to be admired is this, that tho' the Bladder thus turned letteth water thro' it, yet it retaineth the Air as much as if it were not turned; yet Air is a more subtile Liquor then Water. It is impossible to explain this Phenomenon by the Principles of that old Philosophy which we have received from *Aristotle*: We must then suppose, the Pores of the Bladder are larger on the Outside than they are within; thus when the Bladder is turned Inside outward, the Liquor must needs flow out when it enters into those larger Pores which are like so many Funnels; but when the Bladder is turned, nothing floweth out, because the Pores are narrower on the Inside than they are without. why should not the Air, which is a kind of Liquor much finer than water, pass when one bloweth into the Bladder that is turned? It is because in blowing the Air enters with a great Spring, the small Branches or Particles of it are Entangled one with another, and grow stiff against the Pores, and by pressing on the Orifices they stop them up, and thence it is that the Air continueth in the Bladder, and passeth not out at all. Thus you have this Phenomenon Mechanically explain'd, which some have explain'd in too general Terms, by saying only, that the Pores of the Bladder are so disposed and fram'd, as to suffer the Particles of water to pass thro', but not those of Air.

When the more earthly and more solid Particles of the Urine have lost their motion, they are Unmolested and according as they are heavier or lighter they swim on the Surface, or sink to the bottom. If they remain on the Surface they form a whitish cloud; if they sink to the bottom they compose a Sediment which one may look on as the Mud of the Urine. This Sediment doth not always appear in the Urine because the Particles of it are sometimes so dissolved and dispers'd, that they cannot join each other, in order to precipitate themselves to the bottom of the Chamber.

umber pot. They are nothing but the more Sal-
and more Earthy Parts in the Urine, which can-
be melted or dissolved, nor equally mix'd with
other Principles, whence these Particles being
reciprocally joined to each other, do compose or
form a distinct Body a part. When ever these Sa-
and Earthly Parts abound much, the Urine is
thick and troubled.

The Elementary Parts or Principles which one
extracteth from Urine are Water, Salt, Earth and
Sulphur. There is more *Flegm* than there is of all
other Principles as we find by Distillation, since
it is six or seven Times more then the rest of the
Urine. The Salt of Urine, which one extracteth
after the Distillation is no pure *Alkali*, as many be-
lieve it, but a *nitrous Salt*, or rather a kind of *Sal*
nitroniack, that is to say, composed of an Acid, and
Alkali.

C H A P. XV.

Of Transpiration.

Urine is nothing but the Watery and Saltish
Particles of the Blood separated from it in the
Kidneys, so Transpiration and sweat are nothing
but the same Particles strain'd thro' the Glan-
des of the Skin : There is no great difference then
between Sweat and Urine. But it is not enough to
advance this Opinion, we must endeavour to prove
it by good Experiments. 1st. When we Transpi-
re plentifully, we make but little Water ; on the
other side, when one sweateth but little, one maketh
a store of Water. 2^d. During the Winter, one
maketh more Urine, because our Transpiration then
is small, but in Summer one maketh not so
much Water, because one sweateth much. 3^d. The
Taste of Sweat, which is very like that of the
Urine, sufficiently sheweth, that one and the other pro-
ceed

ceed from the Saltish *Lympha* of the Blood, which we have spoke of before. 4th. The Salt which is extracted from Sweat, is like that of the Urine, only it hath not so strong a Smell. 5th. The Sweat of Scorbutick Persons containeth a thick Sediment which leaveth a filth on the Skin, like that Saltish Crust that is found at the bottom of the Chamber-pot. 6th. We observe very commonly, that the Sweat retaineth the Smell of the Food one hath eat, as it is in the Urine, after the eating of Sparaguls. *Salmasius* relateth, that a certain Man, after hard drinking, falling eagerly to work, and sweating much after it, perceiv'd that his shirt smell'd of Beer. We find by Experience, that Spirituous Wines raise a Sweat that hath the same Odour with them. I heard *M. Bernier* the Philosopher say, that when he drank Wine in the Mogul's Territories, his Lining after sweating, smell'd of the Wine, which must be purely ascribed to the Heat of the Place.

Cent. 2.
ob. 25.

One may here form one difficulty or objection against what is here said on this Subject: For Example, one may say that Urine hath a disagreeable odour or smell, and that sweat on the other side hath no smell: But this is easily answer'd by shewing that Wine hath not always an ill smell, and sometimes it hath no smell at all, for unless it be kept a long Time, the smell of it is neither strong nor disagreeable, but if it remaineth but a small Time in the Bladder, it is clear, and without smell, as it appeareth by those who drink much, whose Urine is as clear as Water. In fine, the Sweat having no Basen or Bladder as the Urine hath. when one is in good Health, it never smells ill. To this we may add, that it is not a drop or two of Urine, which makes it have an ill smell, but it is always the abundance of it; so the little quantity of sweat which cometh out by Transpiration can have no ill smell.

It is true, there are some who make very stinking Urine, as there are also some whose Sweat stinks intolerably. If a plentiful sweat succeedeth upon the Retention of Urine, it always smelleth ill. A certain Man had not made Water in a long Time, by reason he had a Fit of the Stone in his Kidney.

kidnies; his Urine flowing back, as I may so say, Salmuth.
 to his Blood, all his Body sweli'd, which was at- *Cent. 2.*
 ded with a general sweat, which smell'd like U- *obs. 82.*
 re: in fine, he voided a Stone at his Yard, and
 the sweat immediately ceas'd, because he thereupon
 voided much Urine.

They say also, that we do not Sweat so often as we
 take Water; but we answer, that the Reason why
 Tears are not so plentiful as Urine is, is this, that
 the Blood which is carried to the cutaneous Gland-
 ularies of the Skin, by the Capillary Branches, arri-
 veth there but in a small quantity, whereas, on the
 contrary, in the Kidnies the emulgent Arteries, which
 are very large, carry abundance of Blood thither.

Sweat is no unprofitable Excrement, as the Anci-
 ents held it to be; it containeth in it certain spiri-
 tuous Particles, Experience sufficiently demonstrates
 since one never Sweateth plentifully, without be-
 coming much weakened thereby.

We have already said, that we lose more by *Transpiration* in one day, than by any other sensible Eva- *Sanatonus*
 in his *Me-*
 dicina *Sta-*

Transpiration is not perform'd at the end of the *tica.*

capillary Vessels, as some have said, since all Filtra-
 tions are only wrought by the Glandules. One may
 say, that the Reason why it hath never yet been dis-
 cover'd whence, or from what place, our Sweats,
 Tears and Snot, were derived, is, that we have not
 been acquainted with the Structure of the Glandules.

There is under the *Epidermis*, or *Cuticula*, a cer-
 tain Net dawl'd over with a kind of Glew, which is
 commonly call'd *Corpus mucosum*, or the *Snotty body*;
 the Teats of the Skin come out at the Net-mesh, or
 holes of this Net, thro' which also pass certain small
 Glandules of a Conical Figure. These Teats and
 Glandules are fastned to the Nervous body of the
 Skin. We shall Treat more particularly of the Stru-
 cture of the Skin, when we explain the Organ of
 Touching.

When the Skin is in its natural Disposition, its
 Glandules, as I may so say, are in a manner imper-
 ceivable; in those Persons who are dried up by long
 sickness, as in Dropfical Persons, they grow bigger;
 truly they do not much exceed the bigness of a

Millet-Seed, whence they have been call'd *Millet*. Moreover, the Reason why these Glandules are more apparent in Lean and wither'd Persons, is, because the Fat which cover'd them is melted away. In fact the Reason why they are bigger in Dropfical Persons, is, because their *Lympha* hardly circulates at all because of Obstructions. Besides those *Glandule Milieares*, there are also certain little Bundles in several places of the Skin, which may be properly call'd *glomerated Glandules*, because they are furnish'd with many little Lobes, and excretory Pipes. It is certainly these last which serve to separate, or strain the Sweat, even as the first serve for insensible Transpiration.

Tho' it be a very difficult matter to determine, how all the Pores of the Skin are ranged, and what the figure is; yet we see that those of the Hands and Feet have a more particular and distinct Disposition. For Example, in the Palm of the Hands, at the roots of the Fingers, and their Ends, besides the great Lines which form certain Wrinkles, with which certain Fortune-tellers, or Chiromancers, amuse themselves and others. There are also an infinity of other Lines which are less, and, in a manner, imperceptible, which form different Lines, some whereof are Spirals and other Ellyptick; there are abundance of them at the end of the Thumb, and in some places in the Palm of the Hand, and Sole of the Foot, there are some, which make some Spherical Triangles.

At the Orifice of these Excretory Pipes, there are certain Small-Convex Skins, which serve instead of *Valves*; they grow stiff, or loosen themselves, according as it is necessary to let the Sweat flow, or retain it, or hinder its flowing. This is the opinion of which one of the most famous Anatomists and Philosophers hath ascribed to 'em, to whom we are obliged for this Discovery; but we have Reason to conjecture rather, that these little *Valves*, do not so much serve to moderate the passage of the Sweat, as to support the effort of the Air which surrounds us; as they are fasten'd to these Orifices, we cannot see how they can hinder the passage of the Sweat: they can be stretch'd never so much, since they look outwardly, and have the same Situation with the

Mr. Malpighi.

in the Lymphatick Vessels, they can no ways in the Sweat. In fine, there's no explaining the reason why they are stretched, or why they are loose; it is said only that they grow stiff and loose, there is no Reason as yet given for it. If there be no Cause assigned for this their Spring, what will hinder the Sweat from keeping them always open by their Motion? They may also shut of themselves, which will certainly hinder Transpiration, and dispose the Blood and *Lympha* to make Obstruction in the Glandules; thus we see, they have not the use which *Malpighi* ascribed to them. We shall be better than to adhere to the Conjecture that hath been laid down, by saying that they are designed to support, or keep off the effort of the Air, and to prevent its opposing Transpiration.

Two Things are absolutely necessary to promote flowing of the Sweat, and preserving insensible transpiration. 1st. The *Lympha* must needs be disposed, that it may pass the better in the Glandules. The Glandules, and their Excretory Pipes must be properly disposed, to let this Liquor flow thro' them; if your Glandules, or their Pipes are any ways impeded, Sweating and Transpiration will be entirely suppress'd, as it happeneth to those who have a thick *Lympha* in their Blood. Cold also hinders Transpiration, not so much by shutting up the Pores, as is commonly said; but rather because, it thickneth those Liquors which circulate in the same Glandules.

Heat therefore by a contrary Reason encreaseth transpiration, not only by loosening and opening the Glandules, and Excretory Pipes; but because, it gives so great a Motion to the nourishing Juice, that the Glandules must needs separate much more of the *Lympha*, at that time than at another; this happens also when one is heated, or that one walketh in the Sun, one Sweateth much; because the Heat rather separates the *Lympha*, and resolveth it into Moisture. During the great Heat of a Fever, one Sweateth not at all, the *Lympha* as being yet too strongly retained with the other Parts of the Blood; but at the beginning of the Fit, one is commonly all over wet with sweat, because the *Lympha* then is become more liquid,

quid, and more Fluid ; being cleared or freed from those Leavens which kept it coagulated. Thus we must explain those great Sweats, which Scorbutick Persons are so subject to ; their Blood being too much dissolved, there is much *Lympha* carried into the Glandules of the Skin.

We have said, that the Glandules of the Skin, must have a Fit disposition for the free flowing of the Liquors, which only consisteth in the Configuration of their Pores. As for the Excretory Pipes, their Orifices must be so fitted and disposed, as they may receive the little Liquor, which is filtrated in each Glandule : Therefore, if these Pipes are stopped up by the filth of the Skin, the Sweat stoppeth within the Body ; on the other side Sweats, are raised by Frictions, because in rubbing of the Parts, the Pores of the Skin are opened, and the filth which stoppeth up the Pores thereof, are carried off or removed, and thus the Liquids are rendred more Fluid, and fitter to be transpired.

The different Texture of the Skin may also facilitate, or retard the passage of the Sweat. If the Skin which is nothing else but one continued Texture of Nervous Fibres, is too dry, that is to say, if all the Fibres are extreemly pressed close to each other, the Glandules, and Excretory Pipes, will be squeez'd together, that the *Lympha* will only pass then in a small quantity ; but if the Skin is soft and smooth, the Glandules being scarce squeezed at all together, and the Pores of the Skin being very open, the Sweat will be the greater, because the Glandules filtrate much *Lympha*. All this is confirm'd by the instance of dying Persons, and such as are surpris'd all on a sudden with Fears and Frights : They are thrown into cold Sweats, because the Blood being generally driven into the Arteries ; when it once arriveth to the smallest Ramifications, it stops and goeth no farther : and since it cannot return by the Veins, the Glandules must needs separate much *Lympha*. And as the Spring of the Nervous Fibres of the Skin, which keepeth them stiff or extended, ceaseth all on a sudden by a Suspension of the Spirits, the Glandules of it are not so squeez'd together, and so they occasion a greater Separation of the *Lympha* : C

Circulation of the Blood is the chief Cause of Sweat, which passing into the Glandules, is there filtrated, whence the *Lympha* is cleared from it by means of fresh Blood which continually floweth, and which driveth on (as I may so say) this *Lympha* like Wedges behind it. to force it into the Excretory Pipes of the Skin. To this may be added also, the Motion of the Particles of the Blood which being more or less rapid, may cause Transpiration or Sweat; which is effected several Ways, for sometimes it is, because the Air is too hot; or sometimes, because it is too cold: And sometimes, also this kind of Evacuation proceedeth from violent Exercises.

Besides the Excretory Pipes of the Glandules of the Skin, there are also an abundance of the Insensible Pores. In effect how should it be otherwise in the Bodies of Animals, whose Skin is so soft; since we find by Experience that Wood, Metals and Diamonds have their Pores, tho' their Particles are so compacted, and so close to each other? By much more Reason there should be Pores in the Skin, and in the Membranes, the Texture whereof is loose, for this covering of the Body, or Membrane, is composed of a Million of little Threads which run a cross at, just in a manner as it is in Cloth; so that they leave every where such a Number of Spaces, that even in those Places, which seem the most compacted, as in the joints of the Finger, or the inside of the Hands, where there are no Glandules, nor Excretory Pipes at all; there is yet a very great Evacuation or Evaporation, because there is every where an abundance of Orifices, or Pores as we have said.

No one hath demonstrated this Truth better than *Mr. Bayle* a certain Learned and Curious *English* Gentleman: *in his Tentamen Porologicum,* He sheweth, by undeniable Experiments, that all Bodies whatsoever do Transpire. He showeth how the Membranes of a Hen Egg are pierced through with an infinity of Pores: And how for Example a new-laid Egg, being placed before the Fire, becometh all wet and moist: He saith it is, because the Membranes which cover the White have certain Pores, which have a Communication with the Shell. Thus by these Pores the Air entereth into the White, in order to make the Nourishment of the Chick Circulate,

late, which being once consumed, and the Chick being now grown big, wanteth much more Air than it did before; therefore he endeavours to get out of Prison, and without tarrying there any longer he breaks the shell with his Bill, which commonly happens about the one or two and Twentieth Day.

Some have said, that the Hen broke the Shell, but one certain sign that it is the Chick that doeth it is this, that the Cleft of the Shell is very fine or small, but always on that side where the Bill of the Chick is placed, this Chink or Cleft afterward groweth larger, because the Chick continually widens it with his Bill, till at last he is able to get out. In fine, if it were true, as some say, that the Hen broke the Egg or Shell, the little pieces which remains fasten'd still to the rest of the Shell, would be beaten inward; but on the contrary, we see that they are rather rais'd outwardly. Besides, if any one will be so curious, as to give himself the trouble to examine a Chick, just about the time of his being hatched, he may hear it scratch, or grate the inside of the Shell with its Nails and Bill, to chuse out the weakest place in it, and when it hath found, there it falls to work with its Bill, and by several small stroaks from time to time given it, he at last breaks it, by which there is made a round Hole. Sometime also we see that the Chick cometh out at the biggest end of the Egg, carrying off with it a piece of the Shell on his Head, like a Cover, or Lid.

The Membranes of all the Bowels like the Membranes of the Eggs are all porous also, for the promoting of *Transpiration*. In fine, besides all that hath been said of the Skin, one may add this, that in the Back of Animals where the Skin is always close and drier than in other places, there are so many Pores, and so large, that one may easily discern 'em without the help of *Microscopes*, it is by these Holes that *Mercury* passeth so easily thro' shammy Leather. Yet these Pores do not always retain the same Figure or bigness in Leather; for tho' it never hath been curry'd, the moisture which kept them swell'd and gave these Pores a certain Figure, being once evaporated, the *Fibres* must needs come closer to each other, the compression of the Air contributing

something to render the Leather more com-

Transpiration and Sweat contribute mightily to the
 purifying of the Blood, and other nourishing Li-
 quors, because this Evaporation carrieth off with it
 an Infinity of Saline Particles, which might other-
 wise heat the nourishing *Lympha*, and render it not
 sweet. From thence one may easily see, that what
Transpiration is hindred, many Diseases after suc-
 ceed upon it, as very dangerous malignant Feavers,
 and cutaneous Distempers, such as the Itch, Le-
 gion, &c. all which depend purely on the Obstructi-
 on of the Glandules in the Skin, as we have made it
 clear in our Chyrurgical Pathology.

Besides the use which is ascribed to *Transpiration*,
 we must observe, that this Dew which flows from
 the Excretory Pipes, is also very proper to keep the
 Teats of the Skin very supple; for this Liquor by
 continually Watering and bedewing these nervous
 Parts, like a careful Gard'ner, that is always Wa-
 tering the Flowers in the *Parterre*, it keepeth them
 always moist, which prevents their being dried by
 the Air, or by the constant touching of the outward
 Bodies. But if this rubbing is often repeated, the
 Skin at last groweth hard and callous, as it is in the
 Soles of the Feet, and Hands of Work-men; there-
 fore these Parts retain not that Sensibility they had
 before this total Disorder of the Teats in the Skin,
 for nothing is more sensible than the inside of the
 Hands, or Sole of the Foot: So it is observ'd, that
 the Tufts and Glandules are bigger, and more
 numerous there, and the excretory Pipes more open,
 and more regularly placed, than in any other Parts
 of the Skin.

CHAP.

C H A P. XVI.

Of Women's Monthly Purgations, or Cour

HAVING already spoken of several natural Evacuations, we come to examine those which Women are regularly subject to every Month. The Blood which floweth Monthly from Women, is a great comfort to them, and helps to preserve them from many Diseases. In this the Power of God is wonderfully manifested, for we may be assured; That the Author of Nature hath given Women more Blood than they want for their own Nourishment, because by foreseeing that Women, and the Females of other Animals, were design'd to nourish another Creature at a certain time, he thought it necessary that females should have more Blood than the Males: tho' it doth not any ways contribute to the nourishing of the *Fetus*, yet it is as necessary, that Women should have abundance of it, only as a Vehicle to convey the *Chyle* to the Child, or Infant; it is superfluous Blood, which in Women is evacuated every Month, when they are not with Child.

It is true, there have been some Men, who have also had these Regular and Periodical Evacuations. It is reported, that there are some *Jews*, who every Month do avoid some Blood at their Yards; there was a Man who voided every Month a great deal of Blood at the Hemorrhoidal Veins, in as great a quantity as most Sanguine Women. When this course was stopped that way, it flow'd at his Mouth without any Effort, Pain, Coughing, or so much as the least Fever. It doth not only flow at the Hemorrhoidal Veins, but sometimes at the Nose.

Lusitanus.

Bartholinus Cent 5. Hist. 33.

All these extraordinary Observations do not in any ways destroy what we supposed at first, as it will appear by that which followeth. Let us now enquire what the Opinion of the Ancients was about the Monthly Purgations of Women; some have said that

Galen.

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ded from the Sedentary Life of Women, and
 if they were not exposed to such hard and la-
 borous Exercises as Men were. Others add this al-
 so, that Women are of a moisture and colder Con-
 stitution than Men, and therefore they have more
 blood, to the superfluity whereof they ascribe their
 diseases: Thus you see the false Theory of the chief
 Physicians amongst the Ancients.

Hippo-
 crates. Ar-
 ristotle.

Why should any one say, that Women are born
 to Repose, and to keep the House? Do we not eve-
 ry day see Women employ'd in hard Service, as all
 poor Women of the Villages, who work in a
 manner like Horses. If we look back in the History
 of the first Ages, we shall find there were some Wo-
 men who were more courageous than Men; nay, we
 shall meet with some who underwent all the Fa-
 tigues of War, as the *Amazons*, and Women of *Spar-*
tan. Thus all that hath been said of the cold and moist
 Constitution of Women, that contributed to make
 their Blood, is only an old story or fiction, not worth
 minding; for to make use of the Word *Tempera-*
ment, how many Women are there which seem to be
 of a hot and moist Temperament or Constitution? Is
 there not Transpiration in Women, as well as Men.
 Nor yet must we imagine, as some of the Ancients
 held, that the second and third Concoction are less
 perfect in Women, than they are in Men, and that
 they have a greater superfluity of Humours than
 Men; is there not the same heat in both Sexes to pro-
 mote the Work of Digestion, the filtrating of the Li-
 quor and Transpiration.

We need not have amus'd our selves with such ge-
 neral notions. But here's a more important Questi-
 on, how cometh it to pass, that Women only are sub-
 ject to these Monthly Evacuations? To this some An-
 swer (with the Scripture) *That if the first Woman had*
not sinned, she had never been exposed to the Pangs of
Child-birth, nor to the shame nor confusion of seeing her
self defiled once a Month with her own impure Blood:
but as soon, saith Helmont, That she had eat of the For-
bidden Fruit, she presently on a sudden felt her Concupi-
sence roused within her, nor was she any longer Mistress
of her own Desires; she ran to look for her Husband; she
concoited, she pressed the poor Man so much, that being
thereby

Van Hel-
 mont.

thereby mov'd with her weakness, and embracing to comfort her; the Pleasure which they reciprocally felt, the first Cause of Original Sin, which was afterwards tail'd on all the Posterity of A D A M.

A most able Philosopher maketh a very eloquent tho' at the same time, (not a very reasonable) Commentary on what *Van-Helmont* saith on this Subject. He saith, That the Apple was a kind of Leaven, which served to ferment the Blood of the first Woman, and this Ferment was afterwards communicated to all Women. But all these kind of Meditations have more of the Divine in them, than of the Philosophical 1st. It is not yet absolutely determin'd, whether Women only are subject to these Evacuations, since Female Apes (as some say) have them also, and some other Female Creatures when they are hot, also void some Blood in a small quantity, yet no one is so weak as to say that these Animals are any way guilty of the Sin of *Adam*. 2^d. Let us suppose, that the first Woman had continued in the state of Innocence, we do not see what could have exempted her from this inconvenience or trouble. To alledge Sin, the cause of this effect, is to recur to Morality, and not to Nature. *Helmont* the younger hath as little reason in this Point as his Father: He maintained That these Evacuations in Women do yield the first matter for forming of the *Fetus*; he further added That no Woman is ever known to be with Child without having her *Courses* first. But we find by Experience, that some young Girls have been found with Child, who never yet had any of these Evacuations. In fine, we have seen several young Women who never had those, and yet have had Children.

Panarolus.

Every one knoweth, that these Evacuations commonly happen but once a Month; yet some Women have them twice in a Month, without any prejudice to their Health. We have known a Woman who was pretty well advanced in Years, who had these Evacuations every Three Weeks in a plentiful manner, without the least sign of the loss of Blood.

Moreover some having observ'd that these Evacuations of Blood happen'd every Month, have therefore ascribed the cause of them to the Moon, but certainly

these Men must be void of common Sense, and on, to ascribe the cause of them to a Thing that so great a distance from us.

When young Maids are fit for Generation, they have these *Monthly Purgations*, which commonly happen about their fourteenth Year, or somewhat later, as when they are arriv'd to sixteen Years, which afterwards continue to fifty Year, and then they cease them, afterwards they grow barren. It hath been said, that these *Purgations* commonly appear at sixteen or sixteen Years, yet it is not always so. I have seen some Children which have had them at their Eleventh or Twelfth Year, and what is very strange and extraordinary, a little Girl brought them on her, when she came first into the World. Some pretend, that this strange Effect was thus occasion'd, the Mother who was with Child with her, one day put herself into so great a Passion, as to bring on her *Monthly Concerns*: This sudden Passion occasion'd the Passage thro' which the Blood us'd to take its common course, and the Blood flow'd that way all the Time she was big; and as it still flow'd, she was seiz'd with strong Pains, and was deliver'd of a daughter. The Midwife was surpriz'd to see Blood flow from the natural Parts of this Infant, it continued to flow for fifteen Days, and then it stopp'd; about a Month after it began to flow a fresh, and so continu'd regularly for Thirteen Months, and then this poor Infant dy'd of the *Epilepsy*.

There was a Woman also of fourscore Years old, who had her *Purgations*; they first had left her, when she was Forty three Years old, without putting her to any inconvenience, from which time she perfectly enjoy'd her Health, till she arriv'd to Fourscore Years; the next Year, that is to say at Fourscore and one, she was seiz'd with a *Tertian Fever*, her *Monthly Purgations* return'd, and flow'd regularly to her death, which happen'd when she was Fourscore and five.

They relate yet a more wonderful Effect, and that of a young Maid, who having cut the Muscle Tendon, which is under the Thumb on the right Hand, she at first neglected the Wound, and look'd on it as a Trifle, and so growing worse, it oblig'd her to make use of several Ointments, which only made the Sore angry,

angry, she address'd herself to the Chirurgions, & did all they could, but all their Endeavours were fruitless: For Nature which was labouring to obtain some passage for her *Monthly Purgations*, having found a passage open in the Hand of this Maid, so ordered that they flow'd that way every Month, which hindered the Wound from being heal'd or clos'd. This poor Girl was much troubled every day to live in this Condition, because she got her Living by the use of her Arms, being a Laundress, Wash-woman by Profession, she was forced to put her Hands often into the Water. All care imaginable was taken to cure her, and the Remedies succeeded so well, that the Wound was in a manner heal'd, & scarce any Blood flow'd there. But upon her falling sick of a great Feavor, there was nothing more to be done with the wound to stop or check the violence of the Feavor, they Let her blood in the Arm. The wound which had begun to be cicatrized, was opened again as before, and the Blood return'd that way as it did at first. Seeing there was nothing to be done for the stopping the course of the Blood, they advised this young Maid, when the Feavor had left her, to have patience, they made her sensible, that it ought not to be stopped; and that her Feavor proceeded purely from the Endeavours which had been made to dry up this Fountain, that perhaps the Blood would at last stop of it self, and return to its common and more natural Channel, and that Marriage was the best Remedy for her, &c.

We have just now mention'd one, whose Course flow'd at her Hand, we shall now mention one who had them at the top of her Head: It was a Girl of fifteen Years, when she had them, the Blood flow'd there so plentifully, that it cou'd a Napkin four times doubl'd. Was not that a wonderful Indisposition, and can we not be surpris'd to see the several ways which Nature sometime maketh use of? She is willing to free herself from a Superfluous blood which is burdensome, and troublesome to her; she finds the common passages either obstructed, or shut up, upon this she maketh a Fountain on the top of the Head, at which she easeth her self of this Superfluous Blood? Can any thing be more surprizing, and more admirable

able? She was sooner and more successfully cured
the other, for she was well recovered in less
three Weeks, and the Blood re-assum'd the com-
Course.

These are the Observations of one who was too
honest, and too Sincere, not to credit or believe *Mr. Ker.*
things he had seen. These Matters, as they seem'd *kerin.*

ordinary, we thought it would be something of
curiosity to publish them in a Book, nor have we
been deceiv'd in this point, for a certain Chyrurgeon
of this City having met with these Observations in
Pathologie, which hath been publish'd for some
time; he said, in Conversation with another very
skilful Master Chyrurgeon, that he had cured a Girl
who had her Monthly Purgations at a wound which
was in her Hand. A certain witty Woman who
heard him, since she remembred the place from
whence he had taken this Observation, she demanded
of him, whether it was any long time since he had
cured a young Maid under cure; the Man presently
confess'd, and not being able to defend any farther
that he had at first advanc'd; they told him, that
he knew as well as he from whence he had them,
in what place he had seen these things. This is
done by the By, to shew that there are some Genius's
so foolish and mean, as to imagine they may gain ho-
nour to themselves, by relating those extraordinary
things which they have heard, or read only in that
manner, as if they had seen them.

It is useles to go about to determine in what time
the Evacuation is perform'd, or what quantity of
Blood Women usually void; There is a difference
in these things in most Women. But we must en-
deavour to discover how the Evacuation is made, and
by what Vessels the Blood floweth.

Most of the Moderns believe that this Blood com-
eth from the *Hypogastrick* and *Spermatick* Arteries,
which water the bottom of the *Matrix*; but when
we go to determine from what part of the *Matrix*
the Blood taketh its Rise or Course, here they are all
divided. Some will derive it from the bottom of
the *Matrix*, others from the *Vagina*. The most curi-
ous of the Ancient Philosophers adhereth to the com-
mon Opinion, he saith, that one may see the Blood
flow

Vesalius.

Roderi-
cus a Ca-
stro. Tan-
trulus
Graef.

Mr: Hyg-
more.

flow from the Inward Orifice in those Women who are troubled with the falling down of the Womb. This Opinion hath many Followers or Champions who defend it. Here are, in few words, all their Reasons. 1st. It is certain that the Blood which nourishes the *Fetus* proceeds from the bottom of the *Matrix*, and after the delivery this Blood cometh from the same place, and this is what is called the After-Blood. 2d. The Vessels which are at the bottom of the *Matrix*, are more numerous and bigger than those in the *Vagina*. 3d. About the time in which Women are disposed to have their Purgations they feel a pain in their Loins, which is occasion'd by the Swelling and Tension of the *Hypogastrick* Vessels. 4th, The inward Membrane of the *Matrix*, according to the Observations, is all full of little Knobs, which are the Orifices of the Vessels. 5th, This is one evident sign that the Blood floweth from the bottom of the *Matrix*, to wit, that it floweth too plentifully. Women with Child, this loss is sometimes fatal to the Mother and Child too.

To answer the first Objection, the bottom of the *Matrix* never falleth altogether out in Maids or Women who never yet have had any Children; it is true, that in some Women who are with Child, the Inward Orifice descendeth very much forward into the *Vagina*, and sometimes in hard Labours, the *Matrix* may be something loosened by the violence it us'd by the Mid-wife. But that this part should fall all together out, this is what can never happen. It is the *Vagina* only which is loosened by Obstructions, and which causeth that great swelling, commonly call'd, The falling down of the *Matrix*. The Blood which floweth in Women, who are troubled with this Accident, proceedeth not then from the bottom of the *Matrix*, since we see it flows out from the *Vagina*.

The frequent dissections of Maids and Women who have died in their Purgations, afford us an undeniable Proof that this Blood floweth from the Vessels of the *Vagina*. In a Girl who was Dissected and who had been hang'd when she had her Courtesan upon her, her *Vagina* was all Bloody, the inward Orifice was exactly clos'd, the inward *Matrix* was

without the least sign of any Blood flowing
 re. I have also Dissected the *Matrix* of a young
 mid who died in the time of her Purgations, the
 outward Lips and the Vagina were Bloody, and not
 much as one drop of Blood within the *Matrix*, it
 is clean and smooth as it is in those Women who
 not Big: In fine, if at any time the Inside of the
Matrix hath been found Bloody, it hath been in such
 Women as died soon after their Delivery, in whom
 the Blood still flow'd from the Orifice of those Vessels
 which open themselves into the *Placenta*.

Thus we answer, at present, all the other difficulties.
 They say, the Blood which nourishes the
 Child cometh from the bottom of the *Matrix*, and
 that even after delivery, the Superfluous Blood flows
 for some time; this we confess is in some Respect
 true, but yet we must not conclude that this Men-
 struous Blood cometh from the bottom of the *Matrix*:
 for is this Evacuation only design'd for easing the
Matrix? Or is it not rather for the Benefit of the
 whole Body? It is sufficient then that this discharge
 is made at some end or extremity, such as the
 Vagina is. If the Vessels then which are at the
 bottom of the *Matrix* are bigger and more numerous
 than those of the Outward Orifice of it, it is not for
 the sake of these Purgations; but it is on the Ac-
 count of the *Fetus* or Child. Besides, the Vessels at
 the bottom of the *Matrix* are covered with a very
 hard and strong Membrane, which hindereth them
 from opening themselves so easily; on the other side
 the Substance of the Vagina is soft and delicate, and
 the Vessels there open themselves presently upon the
 first occasion, let the part be rubb'd never so gently,
 it sometimes happeneth in Coition. For the
 same reason one bleedeth sometimes at the Nose,
 when the Insides of the Nostrils are rubbed a little
 too hard.

As for the pain which Women sometimes feel up-
 on the Approach of their Purgations, there is no
 reason to say it proceeds from the swelling and Ten-
 sion of the *Hypogastricks*; these Vessels are not on the
 region of the Lines, they are much lower since they
 proceed from the Iliacal parts.

Hyg-
more.

They tell us, that they have seen the Inside of the *Matrix* rough with Veins, but what will they conclude from thence? It is not a common thing for the Veins of the other parts to be sometimes varicose when the Blood being hindred in its Course, does not so easily return? Let the Veins of the *Matrix* be full of Knots or Knobs, as they say, that advances not their Opinion at all, since they will have the Purgations perform'd by the Arteries. It is true that Women with Child, who lose much Blood, do in a manner, always miscarry; which happeneth (as some Men-Midwives do maintain) from the great quantity of Blood falling down into the *Matrix*, which looseneth the *Placenta*, and choaketh the Child by drowning it all at once; but it is rather, because the Blood which flows so plentifully, deprives the *Fetus* of its Nourishment, and Air: Of its Nourishment, because of the Chyle which is carried to in great plenty with the Blood thro' the little string. Of Air, which the Blood of the Mother furnishes him with. This is that which destroyeth the poor Child, who is already expired before there is a drop of Blood got into the *Matrix*. If Women who are with Child, have any Hemorrhagies in any other parts, the Child must needs dye, as we find by Experience, and the Convulsive Motions, which it suffers in dying, are the cause why the *Placenta* is loosened from the *Matrix*, and then the Blood must necessarily flow in great quantity.

The greater difficulty is to explain the cause of this Regular and Periodick Flux, Authors bring several Reasons for it, which after we have laid down their Conjectures, we shall Examine.

First, it hath been supposed that Women are appointed by Nature, to be fit for Generation at such a time, and to furnish matter or stuff for the *Fetus* from thence we may very well conclude, that they are not only provided with Organs, which are fit to preserve their own Lives, but with such also as are necessary to preserve the Life of the Child: These Organs are the *Matrix*, and the Parts depending on it. Now, according to this *Hypothesis*, which seemeth very weak, Women abound with more Nourishing Juice than is necessary for them. But least the

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great plenty of Nourishment, which Nature design'd for the Child, might any ways incommode those who are neither with Child nor give Suck, Nature hath particularly taken care to evacuate this Blood every Month; upon the Vessels emptying of themselves, there floweth from them only a certain quantity of Blood, which easeth and comforts them, without doing any prejudice to their Health, they are afterwards, for some time, in Repose; and as soon as ever there is a fresh stock of Blood gathered there, that is strong enough to open the Vessels, the Blood beginneth to flow again. This abundance then of Blood, is, as I may so say, the first goad to excite or provoke this discharge. But whence proceedeth this superfluous Blood? Is it from the Sedentary Life of Women, or rather from their cold and moist Temperament or Constitution? Or is it from their too great heat, as an Antient Philosopher maintain'd? No, all these Causes Contribute nothing to the over-flowing of the Blood; for one may safely assert, that this superfluous Blood is an effect of the natural Constitution, which Women receive on their Birth, which only consists in this, That they have certain Organs which are proper to Form and Nourish the Child.

Democritus.

'Tis in vain to lose time amusing by one's self with these particular reasons, as why the Blood should thus encrease, and then flow every Month? Why it should precisely begin to flow in the Fourteenth Year? Or why it continueth to Forty nine or Fifty Years only? And why, in fine, it stoppeth about that time. These are points above the reach of Humane Knowledge, being pure Mysteries reserved to the Author of Nature. 'Tis enough that we have laid down a probable conjecture, which is taken from the abundance of Blood, and the natural Constitution of Women.

If we reflect on the Diseases Women are subject to upon the ceasing of these their Ordinary Evacuations? If the Bleeding of them relieveth them? If these natural Evacuations do not at all weaken them, may we not reasonably conclude, that what was suppress'd was useless? There are many reasons which make us conjecture that this superfluous Blood is de-

stined to pass into the *Fetus*. 1st. As soon as young Maids are arriv'd to the Age of Maturity, that is to say, as soon as they are capable of conceiving, they feel certain pains in the lower Parts of their Belly which are very violent Cholicks, with a heaviness in their Loins, and a weariness o're all their Body: then beginneth to appear that which is commonly call'd the first shew. 2^d. These *Purgations* cease entirely, and for altogether, in those Women, who thro' their Age, are no longer capable of bearing Children. 3^d. These *Purgations* are stopp'd in Women who are big with Child. 4th. In their Delivery this Superfluous Blood floweth away after the Child is born.

Tho' this System seemeth very plain and natural yet here are some difficulties which one may object against it. They say that there are some Women who in the Time of their *Purgations* seem not to be fuller of Blood, than those who are altogether free from them: And that lean and dry Women are yet Regular in this Point, and do often void much Blood but that which seemeth to destroy this Hypothesis is this, there are many Sanguine-Women (say they) whose *Purgations* are stopp'd, and therefore they urge they do not proceed from the great plenty of Blood. Besides they argue, that supposing it was the great plenty of Blood which open'd the Vessels of the *Matrix* at that time, that it would rather find a Passage thro' the Vessels of the Nostrils and the Lungs, which are fine and delicate, and more easily open'd, than those of the *Matrix*, which have several windings and are encompass'd with a very strong Membrane. We must lay open the weakness of these objections tho' they are propos'd by very great Men.

Mr. Boyl.
Charle-
ton.

To return an Answer to the first, tho' Experience sheweth us, that there are some lean Women, who are as regular in this case as those which are plump, and in good Case: One cannot infer any thing against plenitude of Body from thence, since it is their natural disposition, according to the first Supposition. 2^d. Tho' they have not so much Blood as those which seem to be Sanguine, yet if we consider them purely in themselves, without any Respect to others you will find, that they have always Superfluous Blood.

good enough to promote these natural Evacuations; and as it hath been observ'd. that Women have more good than Men, we have then reason to be assur'd, that the Blood which cometh from them *Monthly*, is always Superfluous.

Besides, we have not so much as one Instance of any Woman having her *Purgations* after her being rain'd or dry'd up with long sickness, or after her loss of Blood at the Nose, or by the Hemorrhoidal veins, or by the opening of an Artery in a Woman, which is otherwise in Women who are naturally lean and languishing. If Sanguine Women, or Women of a Sanguine Complexion have their *Purgations* stop'd, we shall observe, that the flowing of these Evacuations doth not only proceed from the abundance of Blood which determinates them to flow, but also from a certain Spring in the *Fibres* of these Parts. If they are too much extended or stretch'd by the abundance of the nourishing Juice, they will lose their natural Spring, and for want of Contraction the Blood will remain there without passing on any further, as is with the Bladder upon the Suppression of Urine. The same thing happeneth also upon the Blood's flowing back into the Ventracles of the Heart, when there is any *Polypus* there; these things hinder the Heart from contracting its self, and so the Blood is sh'd but gently or softly into the Arteries, and not with that force which is requisite.

In fine, the reason why the Blood floweth at the Neck of the *Matrix*, rather than thro' the Vessels of the Nostrils and Lungs, which are so small and delicate, proceedeth from the particular structure of the *Matrix*, which in that point differ from all other Parts of the Body. Let us not be surpris'd then to see the Blood flow thro' the Neck of the *Matrix*, and not thro' the Nostrils or Lungs, since the Vessels of the *Matrix* are so Mechanically dispos'd, and particularly fitted to receive the Superfluous Blood of the whole Body.

There are also other objections made here, they say that other Animals do not fail to engender, and to bring forth their Young, tho' they have no *Purgations*; these Difficulties do not touch in particular, the Hypothesis here propos'd, but they equally effect all other

other Systems which have been hitherto advanced and we do not see how they that maintain that there is any inward Ferment in the *Matrix* or in the Blood that is gather'd there; we do not see, I say, how they can avoid the difficulty which they advance; for we may ask them, why are not these Leavens to be found in Bitches, Mares, Cows, &c? If they say that these Animals are not subject to these Evacuations, because their *Matrix* is not form'd like that of a Woman, or that of the Female Ape; we know not how they dare to advance any thing that is contrary to Matter of Fact, since it appeareth by dissection, that their *Matrix* in its structure is equivalent to that of a Woman's.

For the better explication of this *Phenomenon*, it is necessary that we observe, that the Females of Animals except Women, grow hot at some particular time of the Year. For Example, the Female Deer suffer not the Male to come near them till towards the 15th day of *September*, about the Feast of *Holy Cross*, then the Male and Female seek after each other, which Time is commonly call'd *Rutting Time*. The young Female Deer seek out the young Male Deer to caress each other, and these their hot Amour lasts about a Month. They choose not out the finest Weather for this Work, but rather a wet and rainy Season. Whence in *Spain*, *Rutting Time* is not till the fifteenth of *October*, when their Rains begin to fall. These Animals as soon as ever they are bred grow furious, and sling themselves on the Dogs and Men without any fear, but at another time they are fearful and cowardly. As soon as they hear the noise of the Dogs, we see that they fly away, and retire to the thickest part of the Woods.

Mares grow hot at Spring, and all Creatures which yield any Wool in the Spring and *Autumn* too. Till about the Summer Solstice, which is the 22d of *June*. The Sow is hot from *February* to the 15th of *March*, the Camel in *September*; the Bear at the beginning of Winter, &c. At that particular time, we may say the Blood of these Animals is more plentiful and hotter, which disposeth them to seek out the Male. It hath been observ'd, that if these Female Creatures in their hot Fit do not meet with the Male

satisfy them, they let fall a little Blood from their
 natural Parts; Cows which are hot, are subject to
 have their *Vagina* bloody: And I remember that I
 have seen a little hot Bitch, which blooded all the
 way as she passed along, they told me they would
 have her cover'd. These Observations do shew,
 that the Females of other Animals have also these
 evacuations, all the difference is, that these Females
 have them only during the time they are hot: On
 the other side as Women generally speaking, are al-
 ways in a condition to admit of the Embraces of Men,
 it is necessary that these Evacuations should happen
 more often to them, than to any other Females.

As to the Blood, which as some say, the great
 Oes do void every Month, that proceedeth not
 from the resemblance it hath of Man, all whose Ac-
 tions it mimicks, as some Moderns have asserted; but
 rather, because this Animal as well as Woman
 is always hot, and so having the Vessels of the *Vagi-*
na all full, they must needs open to ease the whole
 body.

The Egyptians observing that the Female Ape had *An Idol*
 Monthly Purgations, the Priests which belong'd to *which the*
 Temple of *Serapis*, took occasion to feed and keep *Egypti-*
 them, that by them they might more exactly ob- *ans adored*
 serve the conjunction of the Sun and Moon. *under the*

Some have said, that the reason why the Ape had *shape of an*
 these Purgations, was because it had a Figure upright, *Ox.*

that of a Woman; but not to affront, or blemish
 Reputation of this Author, how can four Footed *Duncan,*

Animals be said to have an upright Figure, since they
 never put themselves in this posture or Figure, but
 when they imitate the Actions of Men, or climb up
 Trees? Besides a strait Figure doth not contribute
 any thing to these Purgations of Women.

As to the particular cause of this Evacuation, we
 do not think with the Ancients, that it proceeds
 from the superfluous Blood, that is gather'd in the
 Vessels at the bottom of the *Matrix*, in order to stag-
 nate there a while, and afterwards to flow out. If
 this were true, we should in the dissecting of such
 Women as dy'd upon the approach of their Purgations,
 find the Vessels of their *Matrix* all swell'd, which
 in no ways appear; and if the Blood did thus ga-
 ther

ther it self together in the Vessels of the *Matrix*, by staying there for some time, it being thereupon interrupted in its Course, it would certainly produce an Inflammation in the *Matrix*.

Besides, are the Vessels of the *Matrix* big enough or large enough, to contain the Blood which flows there every Month? That is altogether impossible; we must then seek for some other reason, which one may easily find, by examining the structure of the Part. In fine, that admirable Net-work which is formed by the Veins and Arteries of the *Matrix*, the wonderful structure all over those *Tubes*, which we have described in the Chapter of Generation; In fine, the great number of Vessels for the containing of Blood are not made for nothing. Thus then we explain the cause of these *Monthly Purgations*.

The Blood which is carried by one of the Arteries which watereth one side of the *Matrix*, is spread thro' all these little Ramifications, it afterwards meeteth the Blood, which cometh from the Branches of the Arteries on the other side: Thus these two currents of Liquors dashing against each other upon their meeting, the Blood is something thereby checked in its motion, whence it necessarily passeth more slowly thro' all these Labyrinths, the motion of it is yet more difficult in the Veins, because it striketh every moment against the Angle of these Vessels, thus plunging it self more and more, as I may so say into these Channels or Conduits, pursuing still its circulation, at last some of the finest of the Vessels not being able to sustain the fresh Efforts of the Blood that continually beateth on them, must needs break to make way for the passing of the Blood, and as soon as they shall be emptied, the Circulation of the Blood will move easie or gentle. This will happen in the *Vagina*, because the Vessels which are there are finer, and more dispos'd to open than those which are at the bottom of the *Matrix*, as we have observ'd before.

One might drive this Thought a little farther, and shew, that all those Net-works which are formed by the Vessels of the *Matrix*, are design'd only to water and bedew the *Matrix*, and to be as so many Reservoirs or Basins, which at a certain time must furnish

ish the *Fetus* with all its Nourishment in a man-
For we must look on the *Matrix* of a Woman
Child, or of such as are full, as a true Breast,
which streineth the *Chyle* that is to pass into the mass
the Blood, in order to be carried with it into the
ing of the *Fetus*.

As we have here explain'd the Circulation of the
Blood in the Vessels of the *Matrix*, they must needs
always something extended or swelled, and especi-
ally on the time these Purgations are ready to flow,
reason of the abundance of Blood there; yet in the
recting of a Body, if one vieweth well the *Matrix*,
swelling is hardly perceived in the Vessels; for
one doth not observe it, there must needs be a
considerable swelling upon the Approach of these
Purgations: For whence should those Pains and
Distensions which Women feel sometimes in their
Uterus and lower part of their Belly proceed, but
the Vessels being too full of Blood; and the
Nerves being thereupon too much squeez'd toge-

ther. Besides there are many reasons which shew that
the Blood which is Evacuated by those Purgations,
proceedeth from the Veins, and not from the Arte-
ries. This is the most evident of them, *viz.* That
the Blood is not so Red, nor of so Vermillion a Co-
lor as that of the Arteries, but is always some-
what blackish. 2d. If it came from the Arteries, it
should always gush out with an impetuosity; on the
contrary, it always flows very slowly; thus, since
it cometh from the Veins, we must not recur to the
Tubes of the *Matrix*, thro' which some will have it
pass; for these Tubes which we have spoken of be-
fore, never seem to be filled but when Women are
pregnant with Child, or when the Females of other Crea-
tures are full; this is it which rendreth the *Matrix* so
tender at that time.

This conjecture we have laid down here, will cer-
tainly appear more probable than that *Hypothesis* a-
bout Ferments; since by this supposition all difficul-
ties are solv'd or cleared; whereas, by supposing I
do not what kind of Ferments in the *Matrix* and
other Places, these difficulties still remain unanswer'd:
To shew you the weakness of their Arguments, we
shall

Mr. Boyle,
Charleton

shall Examine them in few words. They say, these Purgations proceed from a particular Ferment of the *Matrix*, which remaineth Idle for some time and requireth a Month for the Fermenting of Blood, which is the cause of these Periodical Evacuations. But before they enter upon the explanation of this *Phenomenon*, they should first prove that there is such a Ferment, and not barely suppose it.

They say it is with this Ferment of the *Matrix* as it is, in a manner, with all others which they suppose in the Brain, the Stomach, the Spleen, the Kidneys, Stones, &c. They should yet observe, that it is not yet positively determined, whether there be any such Ferments at all in Nature, as all these mention. But if they will, contrary to all Reason, still pertinaciously adhere to, and maintain this Hypothesis of Ferments; pray, let the Champions of Opinion tell me, from what place this Ferment is conveyed to the *Matrix*? What is the Nature of it? Is it sharp, acid, or saltish? Why is it hid and conceal'd till such a time? Why doth it not, upon being mixed with the Blood of the *Matrix*, cause any alteration in the Blood which circulates in other places of the *Matrix*? which it should do. Let them tell us, in short, what becometh of this Ferment in old Women, and whither goeth it? Can they can no ways Answer all these Difficulties, let them confess, that these Ferments signify nothing, to the explaining of all Filtrations, and so are to all excluded here.

Charle-
ton.

The Learn-
ed Mr.

Bayle of

Tholouse.

To say yet one Word more about Ferments, I have supposed that the Blood of the *Matrix* grew acid, by the stay it made there. Others speak generally of it, without determining any thing of it, by saying only, that they are certain Saline and Fermenting *Corpuscles*, which, by the great plenty of them, are capable of raising a Fermentation in the Vessels of the *Matrix*, which occasioneth this charge of superfluous Blood. But if it were Acid, some would have it to be, the Blood of the *Matrix* would be Coagulated by it; and so might reasonably apprehend from thence some Inflammation, and perhaps a Gangrene. Besides, this mixing of

, with the Blood of the *Matrix*, which is not
 situated in Women with Child, would prove a
 bad Nourishment for the *Fetus*.

They who ascribe the cause of these Purgations
 to the Influence of the Moon, talk only like Mad-
 men; for what relation or proportion is there be-
 tween the Moon, which is at so great a distance from
 us, and this Periodical or Monthly Evacuation?

Why are Men more exempted from them than
 Animals? 2d. If these Purgations were regula-
 ted by the course of the Moon, all Women of the
 same Age, of the same Constitution or Tempera-
 ment, of the same Climat, would have these Purga-
 tions on the same day, which we find to be quite
 contrary to Experience, since some have them on
 the Thirtieth day; others on the Twentieth, and
 some again on the Twentyfourth, and so on pro-
 portionably. Having now seen that these Purgati-
 ons depended purely on the Superfluity of the Blood,
 and were not effected by any Foreign Ferment; we
 see that all what hath been hitherto said, and all what
 People commonly believe of the impurity of this
 Blood, is only a pure Fable which hath been handed
 down to us by Tradition.

Should we relate all the Fables that pass up and
 down on this Subject, we should never have done;
 I say, that even Looking-Glasses are spotted, if
 a Woman who hath her Purgations on her look-
 into them, and that this Blood spoileth the Wine
 in the Cellar, and that a piece of Bread besmeared
 with it destroyeth Animals. They hold also, that
 a Woman by giving a Man a piece of Cake, where-
 on there was some of this Blood, as a Philter to
 cure his Affections, the Man was thereby Poyson'd,
 and there are several Country Fellows who believe that
 a Woman who hath her Purgations on her, can kill
 young Animals (like the *Basilisk*) only by looking
 at them; they say also, That if some drops of this
 Blood happens to fall upon any Plants, it presently
 withereth and dryeth them up, just as if they had been
 scorched by the Fire.

In fine, they say, That this sort of Blood is never Helmons.
 so vicious till it hath lost its Vital Spirit; that is
 to say, in the Language of this Author, it never
 groweth

groweth virulent, till it is Invested with all the
 ribble proprieties of a Carcass; then it is that
 Linnen as are Died with it cannot be whitened
 the Buck. They add, That this Blood hath as
 a force as the Spirit of Sulphur, which burneth
 Linnen, and every thing that it toucheth.

Pliny. Co-
 lumella.

There are some also that relate so many Ly-
 it, That it would be loss of time even to relate it.
 If Women knew that so many Philosophers
 Physicians have seriously given credit to so many
 fooleries as these, they would have a great de-
 reason to jeere them, especially if one told them
 their Blood burnt their Linnen.

Some demand how it comes to pass that some
 men conceive without ever having their Purgations.
 To answer this difficulty, you must remember
 we have said before, *viz.* That the Mass of Su-
 fluous Blood was, in no respect, the cause of Con-
 ception, since it serves only to hold a Communication
 betwixt the Mother and the Child. Now if a
 Woman Conceive, without having ever had any
 these Purgations, it is because there is not Blood
 enough gathered in the *Matrix* for the promoting
 this Evacuation; or perhaps it proceedeth from a
 particular structure of the Vessels in the *Ma-*
 but tho' there may be not Blood enough to create
 Monthly Course, yet perhaps there may be yet enough
 to penetrate the Vessels of the *Matrix*, and to con-
 vey the Chyle to the *Placenta*.

If there have been any young Girls or Boys who
 have been subject to these Evacuations, that proceed
 purely from their natural Constitution, and from
 their great Superfluity of Blood, which must
 flow every Month, the common way in Girls, and
 Boys at the Hemorrhoidal Veins, or at the Nose.

In fine, to finish this Subject, some say, that
 a Woman Miscarry thro' loss of Blood, or by
 flowing of these Purgations, it is not because
 the Blood which floweth then doth separate the *Placenta*
 from the *Matrix*, but because the Blood, the Chyle
 and the Air, do no longer pass into the little string
 that connects the Child: For the Child in the Womb receives
 his Breath from the Blood of its Mother, as it has
 been already observed, and it is the Elastic Force

subtle Air, which keeps up the motion of the
 ing Liquors of the *Fetus*, without this it
 not live one moment ; therefore if the course
 diverted by any thing, it must needs dye, like
 g Plant that is depriv'd of its Sap, the Air be-
 coming to both of them.

is endeavour to explain Abortion or Miscar-

So great a loss of Blood can never happen,
 at all the Vessels of the *Matrix*, which Form,
 y so say, so many hollow Cavities and Arches
 needs fall down, or sink flat on each other ;
 ing no longer filled with a nourishing Juice,
 Particles, like so many Props or Piles, did sup-
 the Edifice, that is to say, did constitute the
 of the *Matrix*, by giving it this Form of a
 or Arch, the Walls or Sides of it which were
 strong before the loss of Blood, being con-
 , and sinking down flat all on a sudden, they
 needs drive the Child out of the *Matrix* ; the
 fusions which the Child hath commonly at that
 contribute much to the loss of it.

CHAP.

CHAP. XVIII.

Of the use of the Liver.

HAVING already viewed or seen the Function of some parts of the Body, we come now to examine those of the Liver and the Spleen, which contain Organs or Parts that are no ways designed for the separating of Excrements, but for the filtering and straining of certain Liquors, which are necessary for the Animal, especially the Liver.

We shall not amuse our selves or others, by giving down here any exact description of the Liver; we shall only observe, that let it stick never so fast to the Midriff (as we see it doth stick very fast to it) it never prejudiceth or hinders our Respiration or Breathing. We often see, that in some dead Animals the *Convex Superficies* of the Liver is so fastened to the Midriff, that there is no separating of it without tearing its Membrane, and yet they never were troubled with any difficulty of breathing when they were alive; thus the Conjecture of the Ancients upon the Livers being fastned to the Midriff is false. We must not imagine, that the Liver doth any way obstruct our breathing; since in breathing the Midriff sinketh flat down into the Belly, so that the Liver which is fastned to it, is a Weight which facilitates our Respiration, by drawing the Chest downwards, and when the Breast is contracted, that the Midriff riseth up again in a Convex shape. We must not think that the Liver can hinder our motion, because the strings by which it is fastned to the *Diaphragma*, being some of them large, serve as a Bridle to curb the Liver, and by their contraction they prevent the Midriff's being any ways compressed by the weight of it. To affirm what we have said about the Liver's being fastened to the Midriff, I have known the Convex part of the Liver strongly fastened to the Midriff in a dead Bo

was no separating them without tearing the one

from the other. Ancient Anatomists have only look'd on the
as so much Blood coagulated about the Vessels, Hern.
as they call'd *Parenchyma*. He who dissected
most of Animals, seemeth to have been of this
opinion, when he saith that the Liver of Deer newly
looketh like coagulated Blood. But it is but
that the World hath been made acquainted
with the structure of the Liver, for which we are
debt to a most Learn'd and Curious Anatomist, Mr. Mal-
pighi. pighi.

He describeth it under the form of a conglomerated
mass, as he doth also the Brain, &c. He saith,
his own Curiosity prompted him to examine the
structure of these Animals, which the Ancients call'd
solid, and that after he had dissected many of
them. He observ'd, that of all Insects the Snail had
the softest Liver, and that the Glandules of it were
the largest. This Examination and these repeated
dissections made him afterwards conclude, that the
Liver of a Man, and that of other Animals, was like
that of a Snail.

Who hath a mind to view the Glandules of the
Liver with pleasure and satisfaction, must steep it
for four days in hot Water, or else let him first
pour hot Water into the *Vena Cava* to wash it well, it
will become so white, that you may easily discover all
the Lobes thereof, with the small Glandules
which compose it.

There are two kinds of Vessels belonging to the
Liver, some that bring to it, and others which carry
from it. Of the first sort are, the *Vena Porta*,
the main Branch of the *Arteria Celiacæ* and the Nerves;
the Vessels which carry back are these, the *Lym-*
phatics, the *Biliares*, and the Branches of the *Vena*

All the Branches of the *Vena Porta* and the
Nerves have so close a communication with each o-
ther, that they are not enclos'd in the *Capsula* of the
Liver. There is no Anastomosis of the Branches Baccius,
of the *Vena Porta*, with those of the *Vena Cava*, as Mal-
pighi saith, we shall see the contrary by that which Glisson,
Malpighi.

Authors are not agreed about the use of the Liver.
Some have look'd on it as the first and chief Cause of
San-

Sanguification. This Hypothesis hath been generally receiv'd in the Schools without any opposition; others, who succeeded since, have asserted confidently that the Liver did not immediately make Bile, but only gave it that preparation that was necessary for the easier making of it in the Heart. But the true use of the Liver is to separate the Bile from the Blood, which is no Excrement, but a certain Lymph which is proper for its perfection.

Kyperus
Lindenus.

Baccius.

Some say, that the Bile is not strain'd in the Liver, but in the little Bladder of the Gall, and thence carried thro' the *Porus Hepaticus*, in order to be mix'd with the Blood. We shall not here amuse ourselves with all the difficulties these Hypotheses are subject to, we have mention'd several things which speak of the Blood, and the perfection of the Bile, which shew the use of the Bile.

They who maintain, that the Bile is not strain'd in the Liver, do believe, that the Blood which is brought by the Cystick Arteries, is strain'd in the Glandules of the Membrane belonging to the *Cystica*, or Bladder of the Gall; and that one part of this Bile runneth into the *Duodenum*, in order to mix it self with the *Chyle*, and that the rest returneth to the Liver by the *Canalis Hepaticus*, in order to mix it self with the Blood which is carried in the *Vena Porta*. There are many difficulties in this Hypothesis. 1st. If one maketh a Ligature on the Conduit of the Bile, to cut off thereby the communication of the Bile with the *Canalis Hepaticus*, and then taketh away the Bladder of the Gall, we shall find that a great deal of the Bile still passeth thro' the *Canalis Hepaticus*, which sheweth that the Bile is not strain'd thro' the Glandules of this little Bladder. 2^d. The Bile which floweth from the Bladder of the Gall, is very different from that which cometh from the Hepatic Conduit, the Consistence of it, the Colour and smell of it have nothing in them like the Bile of the little Bladder, which is thick, green, and more bitter than that of the *Canalis Hepaticus*, which is always fluid, and never very bitter. 3^d. The *Canalis Hepaticus*, and the * Bladder of the Bile do not communicate with each other in all Animals, for they often fall into the *Duodenum* by different

* Chole-
dochus.

distinct Orifices, or sometimes by one, which is com-
 mon to both Pipes. For Example, In the Viper,
 in the Duck or Drake, after these two Pipes have
 run a great way without having any communi-
 cation with each other, they enter at last into the
Duodenum at the same place. In most of the bigger
 Animals of Fowl, as the Peacock, the Hen, &c. these
 Pipes pass into the *Duodenum* at certain Orifices which
 are at a distance from each other. 4th. If you make
 a Ligature on the *Canalis Hepaticus*, it is filled always
 with the Ligature and the Liver, but not in the
 Gall-bladder betwixt the Ligature and the Gall-bladder,
 which sheweth that it furnisheth nothing. In Dogs,
 two Branches of the *Canalis Hepaticus* which come
 directly from the Liver, are sometimes terminated
 towards the *Canalis communis*, much lower than the
 communication of the *Canalis Cysticus*. 5th. There
 are many Animals which have no Gall-blad-
 der at all, as for Example, Rats, Horses and
 Rabbits, &c.

The Trunk of the *Canalis Hepaticus* doth the Office
 of the *Vesicula*: All the Branches of this Trunk,
 spread thro' all the Substance of the Liver; that
 which is there where the Gall-Bladder is used to be,
 is broad like a little Bag; it is twice as big as the
 Trunk, and is two Inches long; so it is in the Horse,
 and in the Deer. Sometimes there is no Bile at all
 in the *Vesicula*, when, at the same time, the *Ca-
 nalis Hepaticus* is full of it.

Tho' the Membrane of the little Bladder or *Vesicula*
 contains many little Glandules, as well as the inside of the
 Bladder, the Ureters and other Membranes; we must
 therefore say, that these Glandules are for the fil-
 tering of the Bile, no more than the Glandules,
 which are in the Bladder, do serve for the straining
 of the Urine; yet the Glandules of the inward Mem-
 brane of the *Vesicula* do filtrate some small quantity of
 Bile which is mixed with the Bile.

The particular Structure of the Neck of the Gall-
 bladder is enough to convince us, that it receiveth
 the Bile from the *Canalis Hepaticus*, because there
 is a small Knob in the Orifice of it, like that which
 serves for a Valve in the *Pylorus*; it letteth the Bile
 pass freely into the little Bladder, but it hinders the re-

turn of it back again into the *Canalis*, which is confirm'd by the Wind, which swelleth the *Vessica* when one bloweth into the *Canalis Hepaticus*. It is true, that in blowing, part of the Air returneth the same way it came in, because the Air which is bloweth in with any violence, sets open the *Valve* too wide; but after one part of the Air is got out, that which remaineth in the Bladder doth not return any more; because the *Valve*, by stopping up the Orifice at that time, hindereth the passage of the Air notwithstanding our pressing of the *Vessicula*.

In fine, here's the last Experiment for the deciding of this matter. In opening the bottom of a Gall Bladder in a living Animal, even to the Neck of the Bladder, one may observe the Bile come out of the Orifice of this *Canalis*, which emptieth it self into the Gall Bladder. The *Vessicula* receiveth also Bile from several little Branches, which are call'd the *Cystic Roots*.

Pecchi.

There is a great deal of difference betwixt the Bile of the Gall-Bladder, and that of the *Canalis Hepaticus*. The Bile of the Gall Bladder in a Dog, and a Duck, is green, and that of the *Canalis Hepaticus* is black and leadish, as a modern Author hath observed. Perhaps he found the Bile, as he saith it was, but the Bile of the *Canalis Hepaticus* is naturally always more Liquid than that of the Gall-Bladder, which is yet more bitter. If you take the Bile of the *Canalis Hepaticus*, and put it over the fire, there riseth from it a strong mouldy Smell; but it is not so with the Bile of the *Vessicula*. We sometimes find it sweet, in a manner like the dissolution of *Saccharum Saturni*; having opened the *Duodenum* of a living Dog, the Bile which flow'd there was Water, very little colour'd, and, in a manner, without bitterness, being rather saltish than bitter; it came out by degrees, and at several times. Upon the opening of the *Vessicula*, the Bile which floweth out was thick, more yellow, and more bitter, than that which floweth into the Intestine, or Gut.

The Matter, or Substance of the Bile, is deriv'd from the Blood, and not from the Chyle; for in those Animals which are starv'd to death, the Biliary Branches are all full, as it appeareth in Vipers and Serpents.

...s, who have continued a long time without any
nourishment.

The Blood, which is in the Spleen seemeth to be
fitter to make Bile, than that which is in any
other parts of the Body; because the Blood which
is turned from the Spleen, is not simply, or only that
Blood which could not serve for Nourishment; but
we are to look on it as a Liquor quite different from
what it was before. This is what we shall endeavour
to shew, when we come to speak of the Use of the
Spleen. It is very difficult to know, how the Parti-
cles of the Blood are turned into Bile in the Liver.
We have said, that it was the Heat of the Blood Glisson.
which changeth one part of it into Bile, because the
Heat, by its continually acting on the Blood, doth
turn one part of it over again, (as I may so say) which
cometh bitter, just as those things which are burnt
do, have a kind of bitterness.

This Hypothesis is subject to many difficulties. For,
things which are bitter, are not made so by heat,
many things become bitter when they are too
much boil'd, as Sugar and Syrrups, &c. There are
many mixt Bodies, which become bitter, only by
aging of their Particles, without any great Heat at
all. For example, *Crabs-eyes* grow bitter, after that one
pour'd a little Vinegar on them; we cannot say
that this is an effect of Heat: But let us suppose,
that the bitterness of the Bile proceedeth from the
Heat of the Blood, Is this Heat strong enough to
turn one part of the Blood of the Liver, so much as
to make it bitter? If this be so, How cometh it to
pass that Serpents, Lizzards, and all Fish, whose
Blood is cold, have yet a stock of Bile?

They who pretend that the Bile is composed of
more Saline, and Sulphurous Particles of the
Blood, seem to come much nearer to the Truth than o-
thers; for if we examine the Bile, which is so deterfive,
we shall see that it is, in a manner, like a Lee of Ashes,
and it containeth much Flegm, a little Chyle, and a
small quantity of Salt; thus the Bile partaketh of the
Nature of the Blood, and the *Lympha*.

Now, as to the manner how the Bile is separated
from the Liver, the Ancients and Moderns are well e-
nough agreed, since they both pretend that it is by

Baccius
Sylvius
De la Boe.

way of Filtration. Yet some are here to be excused, who will have it, that the Bile is made by Transmutation, and by a particular Tincture which the Blood receiveth from the Glandules of the Gall-Bladder. But this Opinion can never hold, and sinketh in a manner, of it self, since there is always but a very small quantity of Bile in the Gall-Bladder: And even on Supposition, that the Bile was made there, this cannot be by any Leaven, for there is no Ferment in the Organs of the Body, since all that appears in the Parts is a certain Order of the Pipes, Gall-Bladders and Glandules, from whose different Diffusions all Filtrations do proceed.

The Objections which they alledge against this are these. 1st. They say, that the *Bile* is a Liquor which is very different from the Blood, therefore the Particles of it were not in the Blood, before its passing into the Liver: Thus the Blood in filtering itself thro' the Liver, is turned into *Bile*, by mixing itself with the Ferment of the Liver. For all this, I shall still believe, that the *Bile* proceedeth purely and solely from the Particles of the Blood, which have been broken in pieces in passing thro' the Glandules of the Liver. We have already said so many things which prove, that the different Texture, or arranging of the Particles of Bodies, may produce different Colours, Smells, and other Qualities; that we must no longer wonder, that one part of the Blood which passeth into the Liver becometh so different from what it was, since these Particles must needs be directly or variously modified thereby; some of them are entirely divided from each other, others are united, and others again being dashed into pieces lose their former Figure: In fine, all these Particles together, put on a new form, by passing thro' the *Labyrinths*; so that being re-united in the Excretory Pipes, they compose a certain Liquor which is yellow or green, according to the Animal in which they are. It is the mechanick structure of the Liver that which contributes to the forming of the *Bile*, at the time when the Blood is driven into this *Viscus* by the impulse of the Heart, and the alternative motions of the Belly; which by pressing of the Liver together

several times, doth much contribute to the breaking of the Blood into pieces in that Sponge.

The compression of the Liver is the cause of the Bloods running into the Branches of the *Vena Cava*, of the *Bile's* passing into the *Biliary* Vessels on the other side; from whence one part of it is convey'd to the *Vesicula*, and the other to the Guts.

They who are of a contrary Opinion maintain, *Sylvius*, that the Bile which hath been filtrated thro' the Glands of the *Vesicula*, passeth thro' the Hepatick Conduits into the Liver, in order to mix it self with the Blood; for the proof of which, they bring these Arguments. 1st. As the *Capsula*, or Case surrouneth the Branches of the *Vena Porta*, and the *Biliary* Vessels, its Spring must needs drive the Liquor of these Vessels into the Liver. 2^d. By blowing into the *Canalis Hepaticus* there appear on the Superficies of the Liver certain yellow little Bladders, and the Wind then swelleth the Liver, and sometimes breaketh the Branches of the *Vena Cava*. 3^d. The Branches of the Hepatick Arteries being closely join'd to the Branches of the *Canalis Hepaticus*, the Blood which is in that Artery, must needs mix it self with the *Bile*, and facilitate its motion towards the Liver.

To all these Reasons we thus answer. 1st. We deny the consequence they draw from the *Capsula* of the Liver, since other Bowels, as the Spleen, the Kidnies, &c. and even the Arteries and Veins have no their common Cases or Covers, but the Spring which is in them is not strong enough to hinder the flux of the Blood of the Veins, nor yet much less to force the Blood from the greater Branches to the lesser. Nor are we even assur'd, whether the Blood in the *Vena Porta* receiveth more motion than the Liquor which is in the *Canalis Hepaticus*; for the *Capsula* is much thicker at the orifice of the *Vena Porta*, than it is in that place where it covereth the Hepatick Conduit, thus the *Capsula* hath not every where the same Elastick force. It is true, it hath a peristaltick motion, but not successive as that of the Intestins, it is altogether like that of the Arteries, all whose Branches are contracted a little after the impulse of the Blood. This motion is not any ways contrary to that of the *Bile* which cometh from the Liver,

which being pressed together, as we have said, *Biliary* Conduit which receiveth the *Bile*, must direct or convey it out of the Liver.

2d. There is no *Valve* at all in the *Hepatick* Conduit, therefore the Air penetrateth into all the *Bile* Branches, and passeth also into those of the *Vena Cava*. But we must not therefore conclude that the *Bile* passeth, as the Air doth, even to the *Vena Cava*. 3d. The Experience sheweth us, that by pressing the *Bile* together, the *Canalis Hepaticus*, and all the Branches of it are fill'd with *Bile*, yet we cannot say that any such thing can be done in the natural state of it, wherein all its motions are moderate and gentle. For Example, if one squeezeth the *Jejunum* violently forces what is in it towards the Stomach, it will enter again into it, as well as the Wind when one bloweth into the Intestin; but it doth not therefore follow, that it will do so naturally, just as it is syringing the Ureter, tho' the Liquor passeth into the Pelvis of the Kidnies, yet the Urine must flow from the Kidny thro' the Ureters into the Bladder. Thus upon the squeezing together of the Gall-bladder, *Bile* must needs be forced into the *Hepatick* Conduit; but it is presently forced to return into the *Canalis*, because there is no *Valve* at all, and afterwards must fill up the Bladder as before.

Besides the *Bile* passeth neither to the *V. Porta*, nor to the *V. Cava*, but when it is strain'd thro' all the little Glandules of the Liver, it entereth into all the Branches of the *Porus Biliaris*, and from thence into the little Bladder, in order to pass afterwards to the Intestin.

We must observe, that the *V. Porta* furnisheth the Liver with more Blood than the *Arteria Hepatica* doth, because that is but small. If one make a Ligature on the Artery of the Liver, which is a Branch of the *Arteria Celiaca*, the Liver will not fail to strain or filtre good store of *Bile*, because of the abundance of Blood which is brought there by the *V. Porta*.

The *Bile* which floweth into the *Duodenum* is partly that of the *Canalis Hepaticus*, and partly that which is gather'd in the *Vesicula*; but there cometh more from the *Bile*-Bladder, since the *Bile* which floweth into

the *Intestins*, is always like that of the *Bile* Bladder: tho' there be a Ligature made in the *Canalis Cysticus*. Some ask whether the *Bile* floweth constantly into the *Duodenum* without any Interruption, or whether it is at several times; there is some reason to believe that there always floweth a little of it into the *Duodenum*, since in Living Animals one may see *Bile* drop from thence; and when we see that it stoppeth a while, and then beginneth to flow again, it is no natural motion, but it is to be ascrib'd to the Convulsions of the Animal, and to the weakness of the Heart, which pusheth the Blood but gently, and often with an eneven motion.

To know whether the Blood floweth constantly into the *Duodenum*; thus we believe it may be decided.

The Bladder of the Gall receiveth the *Bile* in two places. 1st. By the *Canalis Hepaticus*. 2d. By the *Cystick* Roots. Now this Liquor floweth not by these Channels with a continual motion; but must have certain Intervals for its being gather'd by the Gall and litle in the *Bile* Bladder: The *Bile* Bladder must also have these Intervals, since it doth not force out the *Bile*, but at several times, according as it Contracts its self by the Spring of its

We may believe, that it is not altogether so with the *Bile* in the Liver, which, in a manner, always floweth; for tho' you tie the *Canalis Cysticus*, and take off the *Vesficula*, the *Bile* always floweth into the Guts. This hath been tried on a Dog, in which, after the *Vesficula* wastaken away, the *Duodenum* was always found full of *Bile*.

Some here believe that the *Bile* did not flow or Glissen into the *Duodenum*, till the *Vesficula* was full, which yet happened only at certain Intervals, before the *Choledochus* or Bladder of the *Bile* entereth suddenly into the Guts; so that if there is but a small quantity of *Bile* in the Bladder, it must remain there, till there is enough to cause a Contraction in the *Bile* Bladder or *Vesficula*, and to force out the *Bile* thence, the passage being opened by the abundance of it. But this way of reasoning sheweth, that they spoke only of the *Bile* in the *Vesficula*, and not of that which cometh from the Liver, which,

in a manner, is always flowing. They add also, that the *Bile* floweth not into the *Intestin*, but at certain Intervals, because then when the Stomach is full, that the *Chyle* floweth into the *Duodenum*, the liquidity of the *Canalis Choledochus*, which passeth twixt the Membranes of the *Duodenum*, is too much pressed together to let the *Bile* pass; but the Stomach say they, must be emptied before the *Bile* floweth to the *Intestinum*, as soon as the *Canalis* shall be no longer pressed together.

Tho' this *Hypothesis* seemeth ingenious, yet it is so agreeable to Reason. 1st. The work of Digestion is not finish'd in two hours time, but always requireth five or six Hours; therefore the Gall-Bladder must needs receive a great quantity of *Bile*. Now if it doth not empty its self in all that time, how comes it to pass that it is not burst? 2d. If this *Bile* did not flow out, it might prejudice or hinder the Spring of the *Vessicula*, by which it would be able to drive the *Bile* into the *Intestin*, just as it happeneth in great suppressions of Urine, the Bladder cannot Evacuate it self, because the *Fibres* of the Bladder have lost their Spring. 3d. The Compression of the Stomach, and of the lesser Guts (tho' never so great) doth no ways hinder the *Bile* from flowing out, for thus the *Matrix* of a Woman with Child by pressing on the Bladder, might stop the Passage of the Urine; besides there is always found some *Bile* in the *Duodenum*, which is altogether inconsistent with the foremention'd *Hypothesis*.

Cole in his Treatise of Filtrations. Here's also another Opinion, which is not much different from the former, by which it is supposed that all the *Bile* proceeds from the Liver and Glandules of the *Vessicula*, and that it is pour'd into the *Canalis Hepaticus*, and the *Cava Cysticus* into the *Vessicula*, where it becometh sweeter, and that the *Bile* is not always equally separated in the Liver, that it aboundeth more when the Blood is filled with *Chyle*, and is always in less quantity, when there passeth not *Chyle* enough into the Blood. The Author conjectured, that the flowing off of the *Bile* proceedeth from the Fermentation of the Food which swelleth the Stomach a little; that is to say, according to his Opinion, that more *Bile* emptieth it

the Intestin when the Stomach is full: He saith, during the Work of Digestion, no *Bile* passeth the *Canalis Hepaticus* into the Intestin; because at time the *Chyle* entring into the Mass of Blood is not so much pressed or filtrated in the Liver, for the making of *Bile*. Without entring more particularly into the Examination of this Hypothesis, this great Man will give leave to doubt, whether the Separation of *Bile* is perform'd in the manner as he saith it is, and whether it floweth so plentifully, then when the Stomach is full.

1st. This discharge of the *Bile* into the Gut is not so much proceed from the compression of the Vessels as from the Spring of the *Vesicula*. 2^d. At that time when the Blood is filled with *Chyle*, and there is a greater Separation of it in the Liver, *Bile* should flow in a greater quantity into the *Duodenum*, which is got contrary to the Hypothesis which they have laid down; for they pretend that it floweth less of it at that time. There is no determining the flowing of the *Bile* into the *Duodenum* in the time of Digestion, since it runneth thither, in a manner at every moment. In fine, he will say it, that there is, a certain time wherein there floweth no *Bile* at all into the Intestin, which cannot be, for if it floweth not from the *Vesicula*, it will always flow more or less thro' the *Cava Hepaticus*.

It is plainly evident that the *Bile* which runneth into the *Duodenum* floweth there, in order to mix it with the *Chyle*, and it even floweth there more plentifully, when the Guts are full of *Chyle*, than when they are empty, and in being filled, they squeeze the *Vesicula* together, which putteth the Spring of it in motion, therefore the *Bile* will flow more plentifully than when the *Chyle* is distributed. We must not imagine then, that the *Bile's* mixing with the *Chyle*, can any way hinder Digestion, and on occasion Vomits or Fluxes, as some have said; on the contrary, the mixing of the *Bile* with the *Chyle* bringeth it to Perfection, and renders it fit to pass thro' the small Orifices of the *Vena Lactea*, it seldom or never riseth again into the Stomach, and so cannot cause any Vomiting: Nay, tho' it should flow there, Vomiting would thereupon succeed, and Digestion would rather be improv'd by it, as it appear-

Glisson.

eth

eth from those into whose Stomach, the *Canalis* *is* hath been found to have open'd, as in that *Slave* which *Vesalius* mentioneth, who yet never mited, even in the greatest storms or Tempests.

Besides, in all probability, the *Fibres* of the *Vesicula* are contracted to a certain degree (which they not exceed) in order to expel the *Bile*, just as when one blows into the *Vesicula* thro' the *Canalis* *sticus*: For if one bloweth gently, the Bladder continueth in the same state, because these *Fibres* have not been stretch'd enough, but if one bloweth violently, one part of the Wind will get away, because the *Fibres* are too much extended; so that the motion of their Spring they will drive out Air. We must suppose, that at that time, the *Bile* floweth by the *Choledochus* into the Intestin, there seth but a small quantity of it from the *Vesicula* to the same Conduit.

Malpighi.
Diemer.
broek.

It is necessary, that the *Bile* should remain a while in the *Vesicula*, that it may acquire a greater Activity and Activity thereby, the watery part of it is evaporated or flieth away, and thus the saline Part of it are more at liberty, and more qualify'd to dissolve the *Chyle*. This Conjecture is sufficiently confirm'd by a certain Experiment which some have made on the *Bile*: For having placed it in Digestion over a Sand-Fire from yellow as it was, it becomes green, which certainly proceeded purely from the loss of its more spirituous Particles, which render the Salts more sharp and more acid. In fine, we so find by Experience, that in the schirrous Livers of Animals, as in that of an Ox, the *Bile*, which is found in the Branches of the *Canalis Hepaticus* is thick and greenish, on the contrary, it is more watery or thinner, when the Liver is in its natural state. Now they say that the change which the *Bile* suffereth in schirrous Livers, proceedeth purely from its long stay it hath made in the *Biliary* Branches from some obstruction in the *Glandules* of the Liver.

They who positively assert, that there is a greater Separation of *Bile* when the Blood is all saturated or filled with *Chyle* than at another time, have some reason on their side. But if there is a greater Filtration of it then, it is not because the *Chyle* furnishes

er for the *Bile*, but it is because the *Chyle* which
 mix'd with the Blood, filleth up all the Pores
 of; thus the Mass of the Blood being thereby
 red more bulky, the *Bile* is strain'd off in greater
 quantity. This Supposition is confirm'd by the Ex-
 ample of those, who frequently exceed in drinking,
 they drink a great deal, their Blood must needs
 be full of Water, which watery Particles passing
 through the Veins, must needs be strain'd there in great
 quantity; thence it is that they make water upon all oc-
 casions, are always spitting or blowing their Noses,
 sometimes they fall into the Dropsy.

There is no one will deny, but that when the Sto-
 mach is full, and that the *Chyle* beginneth to flow in-
 to the *Duodenum*, the *Vesicula* must needs be squeez'd
 together, for the *Bile* is discharg'd more particularly
 at that time, when the *Chyle* floweth into the Guts,
 because the *Pylorus* by opening it self at several
 times, receiveth the *Chyle*, which floweth there;
 at the same time also the *Pylorus* striketh on the
Vesicula, and squeezeth it together at several times;
 so that the *Bile* must needs flow very plentifully in-
 to the *Duodenum*, as oft as the *Chyle* passeth into the
 Stomach or Gut.

Having already frequently mention'd the use of
Bile in this Chapter, methinks it may not be a-
 mis (before we finish it) to say something of its o-
 ther Qualities. 1st. The *Bile* of the Liver, and that
 of the *Vesicula* have both of them the same consi-
 stence, which is particular to them, they are both
 somewhat thickish. 2^d. Both these kinds of *Bile* are
 considerably bitter in themselves, and may communi-
 cate that bitterness to other Liquors; for if you pour a
 little *Bile* into Water, the Water becometh bitter,
 and this bitterness of the *Bile* is never so great, but
 you may perceive some sweetness mix'd with it.
 Its colour is always yellow, enclining a little to
 green. We must not imagine that the *Bile* is al-
 ways the same, it often changeth, which may pro-
 ceed from several Causes, sometimes from change of
 Food, or some indisposition of the Liver: In fine,
 the *Bile* is not alike in all Animals. Some believe, Graef.
 that the Acidity of the Pancreatick Juice maketh the
Bile green, by being mix'd with it in the *Duodenum*;
 but

but they are deceiv'd in this point, since it geth green in the *Vesicula*, and it even acquir'd sometime so high a colour, as to be green as a *L* this is what the Ancients call'd *Bilis æruginosa*. The colour proceedeth not from any mixture of the creatick Juice, since it hath acquir'd it in the *Bile* by its too long stay there, because it could flow thence as it commonly doth into the *Liver* by reason of some indisposition.

Besides we may easily learn from what we have said of Digestion, what relation the *Bile* must have with the Dissolvent of the Stomach. We see also of what it may be to the *Chyle*, and to the Pancreatick Juice. There is no need of repeating it any more. Perhaps it may not be amiss here to acquaint you with all the Changes it is subject to, when it is mix'd with different Liquors, what we shall say here, may, perhaps, start some occasion (to those who are capable) to discover the true nature of the *Bile*, and the use thereof.

If one mixeth the Gall of an Ox in the Spirit of Wine, this mixture groweth thick, and you may perceive little Threads in it, the colour of it turneth to an obscure yellow, afterwards it is coagulated, and the Liquor which swimmeth on it is clear, and not so bitter. If one shake the Glass, there riseth a froth in it, and what was coagulated before is dissolved. Leave this moisture for Four and Twenty Hours in a hot place, the Coagulation still appeareth.

If you pour *Cinnamon Water* on the Gall of an Ox, it is also coagulated with several Threads on it, and geth a greenish Colour; in shaking the Vessel, it all turneth to a froth, and the Liquor is dissolved; it retaineth something of a bitter Taste, and something of the nature of *Cinnamon-Water*. Put this mixture in Digestion as the first was, no Change happeneth thereupon.

Mix some of the Spirit of *Sal Armoniack* with the *Bile*, there happeneth neither Coagulation nor precipitation, and from thick as it was, it becometh more and more fluid. From this Experiment we learn that there is no better Medicine in the whole Field of Physick, than the Spirit of *Sal Armoniack* for the dissolution of the *Bile*.

ing of those Coagulations which cause ob-
structions in the Bowels.

The mixing of the *Bile* with the *Spirit* of *Sale*
miack, seemeth to be in a manner of a Golden
; it is bitter, and tastes like Wine; there is no
rais'd by shaking of the Vessel, it continueth a
while in the same state. So it is in a manner
the *Bile*, when it is mix'd with the *Spirit* of
in Blood, it becometh liquid, and more
and put it to digest, it will have a little Sedi-
ment in it.

The Gall of an Ox is coagulated, when mix'd
the Oil of *Tartar*, but it is not so with the Gall
Dog, that becometh more fluid. The *Spirit* of
coagulates the Gall of an Ox into a substance
that of the Yelk of an Egg, which is presently
y'd upon stirring of the Liquor. We observe
some change in a manner, by mixing the *Bile*
the *Spirit* of *Nitre* or *Vitriol*, if one poureth
it the *Water* of *Sublimat*, the *Bile* is coagulated
takes a dark colour, and this Solution after-
s becometh of a blue Colour; but some mo-
after this mixture groweth thick, and of a
colour, and enclining to green. The next
the matter is thick, and of a pale green,
is precipitated. The Liquor which swimmeth
is like Milk, and of a sour Taste, as well as the
ment.

The Oil or *Spirit* of *Juniper* is not easily mix'd
the *Bile*, unless one shaketh the Vessel, the se-
cond or third day the mixture turneth to a rosinous
matter. By mixing Water with the *Bile*, it becom-
more clear, and yellow. The Urinous *Spirit* of
being mix'd with the *Bile*, neither alters its co-
or consistence.

C H A P. XVIII.

Of the Use of the Spleen.

Since the Spleen seemeth to be subservient to the Liver, we shall now examine the Uses of it. Spleen hath been look'd upon a long time as an unserviceable part, which Nature had plac'd in the left *pocondrium*, as a Counterpoise to the Liver. Per-
 Democri- tus, Erasistratus, Rufus, Ephesius. they who succeeded, have been confirm'd in this opinion, from what *Pliny* relates upon the credit of Contemporaries. This most eloquent Nature assureth us, That the Spleen is a great hinderance running, and that to make a good runner, one take out the Spleen. Several Experiments were made afterwards by taking away the Spleen of several Animals, have also confirm'd this.
 Fioriven- ti. A famous Practitioner boasterh, that he took from a certain Woman, a Spleen which weigh'd two pounds. Another saith this Operation was form'd in his Time by two Chirurgions, who sur'd him, that they were oblig'd to take away Spleen from two Persons who had receiv'd Wounds in the left *Hypocondrium*, by which Spleen came out. The like Instances are to be found with in the Works of other Practical Writers. Besides it is known, that Dogs after the Spleen is taken away, are cur'd in a short time, and they grow fatter, and are always eating, and often, and follow the Bitch also more easily. This Operation having been made on Dogs, they open'd them six Months after, the Spleen was found to be like coagulated Milk, the Spleen also hath been observ'd in Dogs, whose Spleen not taken away.

o Animals are cured in a short time after the
hath been taken out of them, we must not
conclude, that the Spleen is useless. Is it not
known that the Stones, the Cawle, &c. are ta-
way without danger, or risque of the Life of the
al? The particular structure of the Spleen,
connexion it hath with other Bowels, and the
positions which it causeth when it self is out of
sufficiently convince us, that it is of great
the Body. It is long since it was known to be
arenchyma, the substance of it is only a heap
bres and little Cells, like those in the Bee-hives.
little Cells are made by the ramification of
einy-Conduit, as the little Bladders of the Lungs
ormed by the Branches of the *Aspera Arteria*,
are fine and slender. Some have observed,
there are certain small Glandules which fill
these little Cells of the Spleen, they sometimes
heaps close to each other, but are also often se-
ed from each other; the Branches of the Ar-
and Veins are insensibly dispers'd there, they
ffer in Man than in Sheep, and yet in a Calf
immediately appear, as soon as the Membranes
ken away, and that the Spleen is well washed
ringing the two Vessels.

Vesalius.
High-
more,
Glisson.
Malpighi.

Malpighi.

well known that the Spleen hath no Excretory
there are a Million of little Branches from the
ck of the *Arteria Splenica*, which forms a kind of
work in the Spleen: Some go to the Glandules
these Coverts or Cafes: In fine, there are also
which empty themselves immediately into the
Venosus.

hard to trace out these Branches even to the
dules, an injection goeth a great way in the
sensible ramifications, but it passeth no farther.
ason sheweth us, there must be some Communi-
betwixt the smallest Branches and the little
for the Spleen having no Excretory Pipe, all
ood which passeth into this Part or *Viscus*, must
be immediately poured thro' the Branches of
arteries into all the little Cells. And it is not
the more subtle Liquors which may pass into
little Cells, but also Wax, by Syringing the
Arteria Splenica upon the supposition of this structure.

I hope

I hope it will appear no longer a *Paradox*, that the *Arteria Splenica* is so much bigger than the *Arteria Hepatica*, because the Blood which passeth to the Spleen is not poured into small spaces, as it is in the Liver; but it enters into a great many little Cells, which being put all together, would make a large Cavity. Therefore the Spleen required a larger Conduit than the Liver, to the end that it might receive more Blood.

Bartholinus, Highmore, Dimerbroek. The Artery of the Spleen hath always a Vein with it, there is no *Anastomosis* betwixt these Veins as many *Anatomists* have said. They are all covered with a Case or Capsule, thro' which the Nerves, which belong to each Branch of the Artery, do pass, which are also insensibly spread thro' the Spleen.

Tulpius, Sepulchretum, Bonet. The Spleen is a part of the Body which is subject to Obstructions, because being altogether a spongy Substance, the Blood may easily gather there. If the return of the Blood is any way hindered, one may perceive, very sensibly, an extraordinary pulsation in the Left *Hypocondria*. Practical Authors have many Instances of this kind; it is sometimes attended with Vomiting of Blood, and Evacuation of it also by Stool.

They Dissected a Man who was thought to be Poyson'd, he died in a short time of an extraordinary Vomitting of Blood. The Ventricles of the Heart, and the *Vasa Majora* had nothing of Blood in them; on the other side, the Stomach, and the Colon were all full of Blood. The outward Membrane of the Spleen was hard and callous, but the substance of it was very soft; there was no Blood at all in the little Cells of it. In fine, they found the Spleen all Schirrus, which made them conclude, that he was not Poyson'd, but that he died of the rising and remounting of the Blood into the *Arteria Splenica*, which was occasion'd by the Schirrus of the Liver.

As to the Lymphatick Vessels of the Spleen, we shall observe, that they do not only run thro' the Membrane of it, but that they enter into the substance of it, as far as to the small Glandules, it is not possible to pursue or trace out the Progress of them either by Dissection or Injection, because the Blood

which floweth from the Vessels which happen to be broken on this occasion, hindreth us from seeing

It is a difficult thing to know the true use of the Spleen, all Anatomists unanimously confess, that there is no part of the Body, whose function is so little known; yet in spite of all these difficulties, the Anatomists have at all times us'd their utmost efforts to discover the use of it; they have spared no pains or diligence; they open'd an abundance of living Animals, and have closely examined their Entrails; In fine, there is no part of the Body that hath been more deeply pried into than the Spleen; but we may boldly say, that notwithstanding all their pains, they yet were never acquainted with the true use of

Let no one imagine here, that we have any design to reflect on those Great Men of former Ages; if they have not been successful in one discovery, they have yet succeeded in others; we must always be oblig'd to them for the pains and laborious search they made after Truth; nay, they are more to be commended than the Moderns, since they first open'd a new way to Science; and have put us, as I may so say, in the right Tract, where we then sometimes assure the Antients, it is not to accuse them of Ignorance, but it is rather to excite us to fresh discoveries, and to prevent others from falling into Errors: whatsoever we know in this Age is nothing but the Respect of what we are Ignorant of, and what the following Ages shall discover or know.

The Spleen hath all along been look'd on by us as the Shop, or Store-House of Melancholly, others have said it serv'd to separate some laudable part of Liquor. The first who will have it, that the Spleen separates the more Earthy and gross Part of the Blood from the other Parts, pretend, that these Impurities are retain'd by the substance of it. This opinion is easily confuted, and falls of its self, for the Blood which passeth to the Spleen, is no way different from that which passeth to other Parts. Besides, when they say, that the Spleen is the Seat of Melancholly, they do not mind what they say, for where is the Vessel to contain it? Is the Spleen a

Vessel like the Bladder, wherein the Gall is contain'd? We cannot say, that the *Vas Breve* and the Hemorrhoidal Veins are the Sink for the receiving this Excrement, since these short Vessels serve for nothing else but to bring and carry back the Blood to the Hemorrhoidal Artery, since that is only Branch of the lower *Arteria Mesenterica*, it would be ridiculous to make it the Excretory Pipe of Melancholly.

In fine, others have imagin'd, that the *Canalis Creativus* was the Excretory Vessel of the Spleen. Some of the Moderns have ascribed this Office to the Lymphatick Vessels. As to this Melancholly to which is insisted on by the Ancients, we know not as yet, what Idea they had of this Word, since there is nothing Earthy in the Spleen, and that the Blood which coageth there, is altogether like that of the other Parts. Besides, they who pretend that the Spleen serves to separate some useful Juice or Liquor, are as much mistaken as the others, whether they hold with some that the Spleen maketh the Blood, or with others that it prepareth an Acid for Digestion.

Aristotle,
Ariteus,
Helmont,
Walæus.

Bauchinus
Platerus,
Spigelius,
Hofman.

Hygmore
Malpighi.

Sylvius, de
la Boe Vel-
thupeus.

The Followers of Aristotle in this point are very numerous, they have all look'd on the Spleen, as the second Liver, which serv'd to make Blood. An ancient Author setteth forth all their Reasons more large, and also addeth others, whom we have answer'd, by shewing the absurdities of this false Theory. As to that Opinion about the Acid of the Spleen it contradicts Experience, since as we find, those animals which have been depriv'd of their Spleen have a better Appetite, and a better Digestion.

There are some Moderns who will needs have the Spleen to perfect the Blood, by communicating certain Spirits to the Blood, as it passeth through this Part, they say, that the prodigious quantity of Nerves which are ramified in the Spleen, by the several Turnings or Windings which they make, produce abundance of Spirits, which by mixing with the Blood, do exalt and ferment it, where the Chyle is the sooner turn'd into Blood. This Opinion is confuted by Experience, since the Spleen carry no Juice into the Parts of the Body.

besides we shall make it appear, that the Use of a great number of Nerves in the Spleen was unknown to them, for the reason why there are such Ramifications in the Spleen, is to prevent the Blood's tarrying too long in those little Cells. All the Nerves supply the *Fibres* of the little Cells, with an abundance of Animal Spirits; whence their Spring is strong enough to drive out the Blood from those little Cavities.

And, as it hath been said, that those Dogs whose Spleens have been taken from them, are more brisk, more nimble, and also more hungry, and piss more, and also more eager after the Bitch than others; which sheweth that it is not the Spleen which contributeth to the Acidity of the Blood.

Mr. *Denis* in his Conferences which he presented to the *Dauphin*, saith that the Spleen serveth to thicken the Blood, and to give it a certain Consistency, which prevents its being too precipitate in its course, and too subtle. But as he doth not discover the Cause of the too great Effervescency of the Blood, there is no necessity for its being condensed.

To say something at present, that may be more satisfactory on the Use of the Spleen, we shall first set down the Opinion of *Malpighi*, which he determines only as a Conjecture that came into his Head. In the Examination he made of this part, he saith, it is very probable, that the Blood which passeth into the Spleen, may receive there some alteration, which may make it something different from what it was before it came there; because it passeth into the Spleen after the same manner as it doth into the other *Viscera*, in crossing thro' the little *Tubes* or small Cells which form the capillary Branches of Veins and Arteries; but the Blood which circulates in the Spleen after it hath pass'd thro' the Arteries and Glandules, it is receiv'd into the larger Sinuses or Cavities and greater Cells, where by its staying for some time, it is so modify'd, as to be able to change the Blood which it meets with in the *Porta*, so that the Blood which is distributed in the Liver, is better dispos'd to be filtrated for the separating Matter for the *Bile*.

There are some who would prove a Communication betwixt the Spleen and the Liver from this, after the Spleen is taken away, the Liver grows bigger. This *Phenomenon* is not always true, for the Liver doth not always grow big in those Dogs which have been depriv'd of their Spleen. If it has been sometime found bigger upon the Extirpation or Removal of the Spleen, it is because the *Arteria Hepatica* doth then carry more Blood into the Liver.

Here is another Observation which is more certain and more important than the first, which shews that there is a Communication betwixt the Spleen and the Liver, *viz.* That the *Bile* is always found coagulated in the *Vesicula* the next day after the Spleen is taken out: From thence we should conclude that the true Use of it, is to dispose the Blood, so that it may be more easily separated in the Liver, making the *Bile*, yet here are two difficulties which may be objected against this System. 1st. That after the Spleen is taken out of a Dog the *Bile* is strain'd in the Liver as it us'd to be. 2^d. That the small quantity of *Bile* in the Glandules of the *Vesicula* is not deriv'd from the Blood of the *Ramus hepaticus*, since that hath no farther Communication with the *Vesicula*. We answer the first difficulty by saying, that tho' it be true, that the *Bile* is separated in the Liver as before, yet this may proceed from another Cause, *viz.* That there is more Blood in the Liver when the Spleen is taken away, and this abundance of Blood may supply the defect of this *Bile*, which would have given the Blood the alteration it receiveth.

'Tis also from this great quantity of Blood in the Liver of Animals who have lost their Spleen do piss forth more Urine, and that they are more greedy and eager after Food. Bitch, for as there passeth more Blood thro' all the *Arteries*, the Filtrations of it are also more copious, for the Dissolvent of the Stomach, which is not else but a *Lympha*, which is strained thro' the Glandules of the inward Membrane of it, is more plentiful. So the Testicles must also needs strain more Seed, and the Kidnies separate more Urine; and so of other Glandules.

Where the Spleen still remains, one may in a man-
 observe the same Changes after one hath well
 ank, which proceedeth purely from the fulness of
 Blood, which is plentifully separated thro' the
 andules, because it is over-charg'd with Serosities,
 the other difficulty is not any ways considerable,
 the Blood of the Arteries, tho' there were no
 een at all, is filtrated also in the Liver, as well
 the *Lympha* in the Glandules of the *Vessi-*

The greatest part of the Blood which passeth into
 Spleen is receiv'd into the little Cells, a little
 ntity of it, is strain'd thro' the Glandules. As
 greatest part of the Blood passeth not thro' nar-
 Channels, but is poured out into large Spaces,
 maineth for sometime in the little Cells, before
 circulates. So this return of the Blood not any
 answering the Impulse of the Heart and Arte-
 , perhaps the fourth part of the Blood will not
 driven from the Spleen at each Pulsation of the
 art. We see then that before all the Blood leav-
 the Spleen, many Impulses of them are necessari-
 requir'd. During all these Intervals, the Blood
 ch remaineth in the little Cells of the Spleen,
 suffer some change, but not by way of Filtrati-
 since the Spleen doth not any way contribute to
 separating any Liquor, not having any Excre-
 Pipe at all. If it so happen out, that the Blood
 ny ways chang'd in the Spleen, it is because, be-
 all of a Spungy-nature, it is there squeez'd, as in
 unge, for the little Cells of the Spleen are not al-
 of the same bigness, since they often change
 Figure, because they are form'd of certain
 membranes which have a Million of Nerves spread
 ver them, which put them continually in action
 the Spirits which pass into the *Fibres* of these lit-
 Cells.

The Blood which is carried into the little Cells by
Arteria Splenica, and which was something vis-
 soon becometh fine and subtle, not by the mix-
 of the Spirits, as many do assert, but because it
 continually dashed and pressed by the Spring of
 the little Cells in which it is contain'd. Thus you
 have in few Words the Modification which the

Blood receiveth in the Spleen, and this is that which renders it fitter to be strain'd in the Liver for the making of *Bile*.

No one as yet, hath explain'd after what manner the Blood is thus modified in the Spleen, exceptable Anatomist, who hath told us something near yet without determining, as we have done now, the true change, which the Blood maketh, or undergoeth in the Spleen, yet we are oblig'd to him for his Thought of his.

It is good to observe by the way, that the Glandules of the Spleen make no particular Separation as *Malpighi* saith, who believeth, that they filtrate strain a saltish Liquor, which is mix'd with the Blood of the little Cells, in order to dissolve it, by which it is more disposed to leave its bilious Particles in the Liver. But as the Glandules of the Liver have Excretory Pipes, they in no manner differ from their Conglobular Glandules, their true use is to filtrate the *Lympha* which returns by the *Lymphatick* Vessels, in order to reach the Store-house or magazine of the *Chyle*. They add also, that if the Glandules did filtrate any acid Juice, it would rather coagulate than dissolve the Blood, since it curdle Blood and Milk, &c.

Many of the Moderns maintain positively the Acidity of the Spleen, since one may perceive it when one eateth it. Perhaps they have a particular Spleen which is distinct from that of other People; for the Spleen was never found to be acid, when it was taken out. To be more assur'd in this Point, they boil'd the Spleen of an Ox newly taken out in Milk, which did not curdle it; nor did it so much as change the Colour or Taste of it, which would have been otherwise, had there been the least Acidity in the Spleen.

There are some Persons of Credit and Reputation who say, they have drawn by way of *Analysis*, an Acid Salt from the Spleen; if that is true, we must believe, that the Fire had made it by changing the Particles of the mix'd Body, that which proveth that the Salt was not one of the Principles of the Spleen is that they maintain that this Salt being put into the Blood or into Milk, doth coagulate it. Yet the

of the Spleen in Milk caus'd no coagulation, nor when it was boil'd in it.

They say also, That a Decoction of the Spleen of an Ox is a powerful Remedy to promote the *subly Purgations*, and to remove the obstructions of the Spleen; because that Liquor is Impregnated with a Salt something like that of *Virriol*. It is yet such, that it neither tastes of Vitriol or Salt. Besides, there is any benefit in this Remedy, it proceedeth from the Spleen, but rather from some Ingredients which are mix'd with it; and if one hath the curiosity to make an extract of the Spleen of an Ox, one will only perceive the Taste of something that is different, as it is in all other extracts which are prepared by boiling.

In fine, to finish our Conjectures on the use of the Spleen, here are some Experiments which have been made which will serve to confirm what we have said. All the Spleens of Living Animals which have been Examined, the Blood was never found to be Thick or Viscous; but on the contrary it hath been always more fluid and thinner than that in the other parts of the Body.

If one make a Ligature on the *Vena Splenica*, and on the Arteria, and afterwards put the Spleen in its place again, by sowing up the wound of the Arteria, two hours after one shall find the Spleen all of a Vermilion Blood, provided the Dog is Living. This fine scarlet colour purely returneth to the Blood, because it could not get out of these little Cells of the Spleen; it hath been so strongly pressed, that the Particles of it were violently turned out on their own Centre, by a circular motion; and the Blood which the Artery driveth there a fresh, maketh the Blood also turn round in the Spleen, because by entring all at once, and not being able to get out, all these Particles beat one against another, they pass from these little Cells to others; this makes them also turn, with a rapid motion, just in the same manner like the Blood which passeth into the little Cells of the Lungs, moveth circularly, which renders it Red.

The Blood which is taken from the Spleen maineth a long time red, or of a Vermilion colour and fluid, and it is a long time before it is curdled or coagulated, or that the Lympha is separated from it. If one tastes it, there always remains much sweetness in it; on the contrary, the Blood which is taken from the Veins is presently Coagulated, and in less than an hours time the serosity is separated from it. All these experiments shew very well that the Blood of the Spleen is different from that which is in the other parts of the Body, since it is more fluid, sweeter, and of a more Vermilion-colour. This must needs be so, since it hath been so proposed.

TOME II.

In which the Organs of the
Outward and Inward Senses
are accurately Describ'd.

By the same Author.

T O M E II.

C H A P. I.

Of the Nature of the Animal Spirits.

It was a common Opinion heretofore, that the Spirits serv'd only for Motion and Sense, but it is plain that they contribute also to the supporting of the Life of the Animal ; for where the course of Life ceaseth, or is entirely interrupted, as in the case of an Apoplexy, one is in danger of losing one's self : Thus we see that those Functions which have been hitherto always call'd Animal, are also, at the same time, Vital. In Effect, what signifieth the term Vital ? But something that keepeth up Life ? Now Life purely dependeth on the Motion of the Heart, and of Respiration, which may also be stil'd Animal, since they barely depend on the Motion and course of the Animal Spirits.

By Animal Spirits then we understand a certain delicate matter, which is filtrated or strain'd in the Brain : Those Spirits are the cause of all motions voluntary, or not Voluntary. Some say the Soul maketh use of these Spirits as the Instrument, by which she Executeth her Functions. Others are of opinion, That these Spirits are the Principle Foundation of that which is called the sensitive Soul ; but with the subtilty of any Body, tho' it be never so great, make it less matter ; yet some have imagin'd, that matter, by being much subtiliz'd, may grow so fine and spiritual at last, as to be capable of thinking, which is a pure ridiculous Whimsey ; for one matter is not more subtle than another, but only as it is divided into lesser parts, and those more agitated ;

Mr. Lamy
Treaté de
L'Ames-
sitive.

ted; so it also maketh a less resistance to other
 dies, and more easily insinuates it self into their Po
 But let it be divided, or not divided, agitated
 not agitated, it is still matter, and still corporeal,
 never the more capable of Thinking, since there
 ways remaineth the same difficulty and disposi
 betwixt a Thought, and matter subtiliz'd or refin
 as there doth betwixt it and Matter, which is m
 gross; it being impossible to conceive that any M
 ter which did not think then, when it was in
 pose, as Earth, or in a moderate motion, as Wa
 or Blood, should come to know its self by being
 more agitated or tossed up and down, or by giving
 three or four wambles more. One might here
 large much on this Subject, but this is enough
 the understanding of the greatest part of other
 fus'd Idea's, which proceed, in a manner, from
 same cause, we even now mention'd.

Succus, 10 Most English Authors give us an Idea of the A
Nervosus, mal Spirit, under the form of a Liquor, which t
Mr. Borel- call the juice of the Nerves, or Nervous Juice, wh
li. is fit also to nourish the Parts, and even a learn
Italian Mathematician will have this Juice to be a
 quor which nourisheth all the parts of the Body,
 he will not have it contribute any thing to Sense
 Motion, as the Spirits do.

We cannot imagine that any one can either do
 of the existence of these Animal Spirits, or that t
 serve for Motion and Sense, But least any Obj
 that we rather suppose than prove them, here
 the strongest Arguments to prove their Existence
 1st. There are certain *Phænomena's* in Anim
 which cannot be ascrib'd to any motion of the se
 ble Liquors, and much less to that of the solid pa
 For Example, their motions and sensations do
 proceed from every thing that striketh on the Sen
 as from their Cause, but from a certain ætherial M
 ter, which falleth not within the Ken of our Sen
 2d. The particular structure of the Brain, and
 Nerves, well sheweth that they have some particu
 use, which is to filtrate or strain, and distribute
 Spirits. 3d. If the Functions of the Brain or Ner
 are once interrupted, all Animal Actions immedi
 ly cease, as it happeneth out in great wounds

Head, on which occasion the Brain is squeez'd
 either by the Blood, or by some pieces of the
 Nerves, or when one maketh a Ligature on the
 Nerves.

Motion and Sense are not perform'd by the sole
 Tension of the Nervous Fibres, nor by that of the
 Membranes. The Champions of this opinion are
 very numerous, for besides the Antients who have
 asserted it, some Moderns also believe it. The string
 of a Musical Instrument (say they) cannot be pinch'd
 at one end, without shaking the other end of it
 also, and so it is with the Nerves; but the motion
 of the Muscles destroyeth this their Opinion, since in
 their most violent contractions, the Nerves are ne-
 ver observed to be more extended, and they are as
 flexible, and as loose as they were when the Mus-
 cles were without any Action at all: What will
 become of this violent Tension of the Nerves,
 which some suppose, in Convulsions? For to assert
 that these Convulsive motions proceed not from any
 water-natural Liquors that irritate the Nerves, but
 from some shaking or shog of the Membranes of
 the Brains, which stiffens and stretcheth the Nerves;
 this is not explaining the nature or reason of Con-
 vulsions. 2d. We see that there is no proportion
 at all betwixt the motion of the Muscles, and that of
 the Nerves; nay, there are some Muscles so prodi-
 giously strong, that all the Nerves together (tho'
 never so stiffly bent) would not be able to move
 them. 3d. The trembling which happeneth to the
 string of a Musical Instrument when it is pinched,
 produceth the sound; but this motion is too small
 or too weak to move the Instrument to which it is
 fastened: Thus we see that the Tension of the Nerves,
 if any such thing be, would only render them capa-
 ble of Trembling, but never enable them to move
 the Muscles. 4. The Nerves being of a soft and
 flexible substance, they are no ways capable of any
 Tension, or being stiff, unless we imagine, that there
 is some secret Power that makes them so; or rather
 suppose, that there are certain small Bodies which
 inunuate themselves into their Pores, like so ma-
 ny wedges to keep them stiff and bended, just as
 water shortens Cords. But there is no such power
 for

for the stiffening of the Nerves after this manner; that we can believe only of the Motion of Muscles, is, that the Spirits pass from the Nerves into the *Fibres* of the Muscles, as we shall see, when we come to treat of the Motion of the Muscles.

Argen-
sier.

It is a long Time since one of the ablest Commentators on *Galen* denied; that there were any such Thing as Animal Spirits: He saith, that there is but one Spirit diffused thro' the Mass of the Blood. Here are the Arguments he bringeth to prove there is no such Thing as an Animal Spirit. 1st. The Animal Faculty which resideth in the Brain is able by it self alone, to produce the Animal Actions, without the concurrence of any Spirits. 2^d. The Solidity and hardness of the Nerves hindereth the passage of the Spirits. 3^d. When the Blood is not carried to the Head, Motion and Sense are presently lost. 4th. It is not yet certainly known in what part of the Brain these Spirits are formed. 5th. If the Brain was always fill'd with these Spirits, one would be always thinking without any intermission, and there would be continual Sensations; which is yet contrary to Experience, since all Sensations and Thoughts do entirely cease when we are asleep, and in certain drowsy Distempers, as in the Lethargy and in the Coma. 6th. That the Brain doth not furnish either Nerves or Spirits enough for all the Parts of the Body. 7th. If we make a Ligature on the Nerves of a living Creature, they do not swell at all above the Ligature, which would be otherwise, did they carry any Spirits. 8th. The Nerves have no Channels or Conduits to carry those Spirits to the Brain, as the Veins have for the conveying of the Blood thither. In fine, he hath many other Arguments, too long to be related here, and therefore we shall be satisfied, by answering what hath been here said on this Subject.

1st. It is a pure *Chimera* for any one to assert, that there is any Faculty without its proper Organ, or Accident without its Subject, for as we cannot say that the Light is a simple Quality without any Subject, but rather a corporeal Substance, consisting of several globular Parts, which are reflected when they

meet with *Opake Bodies*, and pass thro'
 which are transparent ; so by the Animal Fa-
 we must understand, those Animal Spirits
 contribute to Motion and Sense. 2d. The
 dity of the Nerves is not so great, as to hinder
 passage of the Spirits, since they are full of
 3d. One may easily explain why Motion
 Sense altogether cease, as soon as the Blood pas-
 no more to the Head ; the Reason of this is, that
 Brain then filtrates no more Spirits to supply the
 of those which are dissipated by the several Mo-
 of the Body. 4th. *Largentier* hath some reason
 dispute with *Galen*, about the place where these
 Spirits are form'd, since it is neither in the *Plexus*
vides, nor in the *Rete Mirabile* of Animals, nor
 in the Ventricles of the Brain ; but he is mista-
 in excluding the whole Brain in this case, since
 it is the only part of Animals, which serves for
 raining of the Spirits. It is true, that this Separation
 is not made in the Ventricles, nor yet in the
plexus, as it hath been said, but in the Cortical or
 rky-substance of the Brain, which is the proper
 are for the straining of this subtle part of the Blood.
 The Spirits being in a continual Agitation,
 me of them must needs enter, or slip into the
 racts of the Brain, and there form several Idea's
 when we are asleep ; thus in the profoundest Sleep,
 men, as well as other Animals, have different Ima-
 nations. 6th. Tho' the Nerves which are deriv'd
 from the Brain are not very numerous, yet if one ob-
 serveth their several Branches proceeding thence, we
 shall find, that they are as numerous as the Arteries
 and Veins ; For we must look on the *Medulla Allonga-*
ta, as the Trunk of all the Nerves that are spread
 thro' all the Parts of the Body, just as the *Aorta* is the
 Trunk of all the Arteries. 7th. It is a Problem
 which is not determin'd without great difficulty ; to
 know, why the Nerves do not swell at all upon a Li-
 ture made on them, yet we shall endeavour to de-
 termine it and shew, that this Experiment doth not
 any ways destroy the Existence of the Spirits. 8th. If
 the Nerves have no Vessels to bring back the Spirits
 to other Parts of the Body, which are furnished
 with Veins and *Lymphatick Vessels*, it is because
 there

there is no necessity that the Spirits should rise from whence they came.

We have already said, That we should entertain no other Idea of the Spirits, than to imagine them as so many Elastick Particles, which communicate motion to the Blood, and which are strain'd thro' Cortical Substance of the Brain. But to attempt to determine the particular nature of the Spirits, is to plunge one's self into insuperable difficulties. What Knowledge can we pretend to have of the Spirits, since they come not within the reach of our Senses. To go to determine their Essence by their Effects, we shall find nothing in the whole System of Nature that entirely agreeth with the Spirit. Thus they who have defined them to be the most subtle part of the Blood, have therein acted at least prudently, tho' not Philosophically. The general Idea, which they have given of the Spirits, has prevented them from falling into great Absurdities, and in all their Theory we shall not meet so much as with one Hypothesis, but it is otherwise with the Moderns.

Willis de
Animo
Brutorum.

For Example, here are some who have compared the Spirits to Light, for as the Rays of Light, they, are derived from the Sun, as from their Fountain, so the Spirits do proceed from the Blood; they are as a most pure and nimble Flame, which floweth, or is darted from the Brain thro' the Nerve.

They who are pleas'd with this Fable, do all they can to support the Credit of it; yet all they advance in favour of it, is more plausible and glittering than it is solid, as we shall presently make appear. 1st. They assure us, that the swiftness of voluntary motions, is an Argument that the Spirits partake of the nature of Flame or Light, which they prove also by the changes that happen visible to the Eyes in some diseases, and during our Passions. In the State of Health, the Eyes have a moderate Lustre and Splendor, in Persons who are dying, they languish and lose that Brightness; on the contrary, in such as are Frantick, the Eyes are so sparkling that they seem to be all on a fire. If the Lustre of the Eyes is moderate when one is well, it is an Argument that the Course of the Spirits is neither too

erate, nor too slow, but keep a just medium between the two extremities. If the Eyes are dull languishing, when one is dying, it is because the Spirits have been exhausted and dissipated by the same; on the contrary, if the Eyes are lively and shining in *Delirium* or *Phrenzy*, that proceeds from the great motion of the Spirits which is a Fermentation, a Tumultuous Efferve-

scence. These reasons are not strong enough to convince that the Spirits are of the nature of Light: The Spirits have a greater Activity, and a quickness than Light, which consisteth only on the motion of the Ethereal matter. 2d. The comparison which they make betwixt the Spirits and Light, is very just, in saying, that Light is some real quality which is not in the Eyes of those who perceive it, and that this quality is in the luminous bodies, as well as in us: But by Light we must understand the pressure of Ethereal matter on the Retina which is communicated to the Brain by the Spirits to imprint on the Soul the Idea of this Motion. We see then that Light is also an Idea of the Soul, as well as the pain which proceeds from a Needle which pricketh us, is one. 3d. Tho' even the Light and the Spirits were of the same Nature, their motions would not yet be alike, since Spirits pass thro' solid Bodies, as the Nerves; whereas Light passeth thro' such as are Transparent. In fine, the natural properties which are ascrib'd to the Spirits, do not agree at all with that of Light. For Example, we may say, that in a Phrenzie the Spirits are inflam'd with the Spirits of *Turpentine*, or some other Sulphureous Spirits; That in Mad and Melancholick Persons, the Spirits are as Acid as *Vinegar*, and sometimes as corrosive as *Aqua Fortis*; That in those who are stupid and capricious, these Spirits loose all that is sweet, or moderately Saltish: They add also, that the *Succus Nervosus* is charg'd with good store of Sulphur, and that the Blood is full of Sulphur; That the mixture of these two Liquors in the Muscles, is like a kind of explosion like that of Gun powder, when it is set on fire; but do these proprieties agree with Light?

1st. The Analogie which they make betwixt the motion of Light, and that of the Spirits, is not just: They say, that the Spirits are diffused from the Brain thro' the Nerves to the extremities of the Body, and that the Objects shake the Organes of the Senses, are the cause that the Spirits return to the Brain in an Instant; it is true, that the Spirits do return after this manner, they are not therefore by consequence like Light, there are other Bodies besides the Light which communicate their motion in an Instant; in order to perform this, their Particles must touch one another, and be compos'd of a moveable Figure, so that they may all at once communicate their Impression, even as if they were but one continued Body.

2d. The lustre and liveliness of the Eyes do not always shew that the Spirits resemble the Light, if we well observeth, why the Eyes seem to sparkle on several occasions, we shall see that this Lustre or Sparkle is not a Light that cometh from the Spirits, but an effect of the Light which surrounds us, which is reflected on the Retina, by making refraction of the Humours; so that according to the different Transparency of the Humours and Membranes, the Eyes have more or less Lustre: If the Humours and Membranes retain their usual Transparency, and are neither too much bent, nor too loose, much Light will enter into the Eyes, one part whereof will be reflected outwardly with the same swiftness as it entered then, and this will render the Eyes bright; on the other side, the Eyes will be languishing and dull, if the Humour have lost their Transparency, and that their membranes are grown either too thick or too much relax'd or loose, because then the Light will enter so little Light into the Eye, that none will be reflected outwardly; therefore it is that when People faint away, and are dying, the Eyes have more Lustre, and are put out. But why do the Eyes seem to be all on fire in a delirium, is it from the great agitation of the Spirits, which are then inflam'd? Do not imagine any such thing, for though it be true that the Humours and the Spirits in burning Fevers, and in a *Delirium*, are in a great agitation, yet their sparkling of the Eyes proceed not from the

on of the Spirits, but from the Blood, which
 eth and filleth up all the little Pipes of their
 branes; the Vessels of the *Retina* and the *Cornea*
 all filled with Blood, thus the Light which re-
 eth from the bottom of the Eye, being of a Red
 eficies, must needs receive a circular motion, and
 is consisteth that shining redness of the Eyes.
 brisk Lustre and glittering of the Eyes depend-
 then on the Mechanical structure of the part,
 or on the Spirits.

me are of Opinion, That there is nothing more Mayow.
 er to make Spirits than the Nitre of the Air,
 h by passing with the Air from the Lungs into
 blood, is carried to the Brain, which they prove.
 By all violent Exercises, in which Respiration is
 frequent, because we have then more need of
 ger quantity of Nitre to Repair the loss of
 es, that ariseth from the extraordinary motion of
 Muscles. 2d. All these motions proceed purely
 the mixture of the Nitre of the Air, with the
 e and Sulphurous Particles of the Blood, which
 e a kind of explosion in the *Fibra Motrices* of
 Muscles. Now, according to this *Hypothesis*, the
 e and Sulphurous Particles of the Blood cannot
 eed from the Brain, and nothing but the Nitre
 e Air floweth from the Brain into the Nerves.
 then this Nitre which is the matter of the Spirits.
 The Nitre of the Air being very subtle, and ca-
 e of a Spring, it is also very proper for the mo-
 of the Muscles, for they require a matter that is
 ed with great Activity. 4th. The Spirits be-
 subtle, they are easily dissipated, nothing then
 the Nitre of the Air can suit with the Spirits,
 it is so volatile. 5th. The Nitre of the Air is
 necessary for the supporting of Life, as the Ani-
 Spirits are; for we observe in Insects, that the
 ters of the *Aspera Arteria* extend their Branches
 all the *Medulla Spinalis*, but more particularly in
 Knobs of it, which serve as so many *Cerebella*
 urnish matter for the Spirits; and by that we
 explain, why an Insect being cut into many
 each moverh of its self, because all the parts
 e a Heart and Lungs: For all Insects, in a manner,
 e a Heart like that of a Silk worm, which reach-

eth from the Head to the Tail of it. It is composed of many other little Hearts, over which the Gristles of the Lungs make a kind of Net-work; the Branches of these Gristles open into the Ring of the Belly of the Insect, and every Orifice is a kind of *Larynx*, thro' which the Air passeth into the Lungs. These Orifices are not always of the same number, sometimes they are more, sometimes less. For example, in *Grass-hoppers*, and in the *Grillo-Talpa*, there are six of each side; therefore when these Insects are cut in pieces, every part breatheth, and one may perceive in them the motion of the Heart.

*Lib de
quantitate
Anima.*

St. *Austin* relateth, that one of his Friends took an Insect which had several Feet, and putting it on a Table, cut it into two pieces, and that, at the same time, both the parts began to march, and fly as fast, one on one side, and one on the other; this was no Irregular motion, for they march'd as if they had been but one entire Animal; when they were composed with any thing, or that they were beat upon one side, they turn'd very well about, and flew towards the other side. They also cut each of the parts into two and then all the four pieces march'd just as if they had been four distinct Animals; tho' they still made a farther division of them, each divided part still had Life in it. This great Doctor confesseth he was ravish'd with the admiration of this Experiment, and that he continued, for some time, without knowing what to think of the Soul, or the Nature of it; but the admiration of this Experiment would not have been so great, had he been well acquainted with the structure of Insects, or with *Mechanisme*.

*The Machine of
Magde-
burg per-
fected by
Mr. Boyle.*

To go on with the reasons of *Mayow*, he saith in the sixth place, that Animals put in a *Vacuum*, are subject to Convulsions, because they are depriv'd of Nitrogen. 1st. That Phthisical Persons, and all who are infected in the Breast or Lungs, want Spirits. 8th. That the Plague, and in all other Pestilential Fevers, there is a great irregularity in the Course of the Spirits. 9th. That the Animal Spirits have a great affinity with the Nitre of the Air, because they are also very soon dissipated. In fine, he adds, that the Brain containing much Salt in it, and no Sulphur

apt to be impregnated with the *Nitre* of the
which the Blood conveyeth to it for the making
the Spirits.

But there is nothing falser than this Hypothesis;
Existence of a particular *Atmosphere* of Aerial-
e, distinct from that of the Air, could never yet
emonstrated. Tho' the Air is full of Saline Par-
s, they are not deriv'd from this *Atmosphere*, but
from the evaporation of Earthly Bodies, because
there are abundance of Vapours in the Air, we must
therefore imagine, that there is a Sphere of Wa-
above the Air, from whence the Rain cometh.
It is well known that Vapours are rais'd from Wa-
and moist Bodies, in order to fall down again,
in the form of Rain. We must not then say, that
the *Nitre* of the Air hath a particular *Sphere*: For
it is soever is heterogeneous in the Air, proceedeth
entirely from Earthly Bodies, as it hath been said.
It is true, that Air is necessary to keep in the Flame,
but this is not from its *Nitre*, but purely from the
motion of certain small Spirals or Rollings of the Air
in several Circles; which circulating near the Flame,
keepeth all the Particles of it in Agitation, and the
Motion which it communicates to the small Parts
of the Fire hath shaken, is enough to furnish
a fresh Flame in the room of that which is dissi-
pated; thus the Air by its natural Spring, and the
great quantity of subtle Matter which it carrieth to-
wards the Fire, preserveth the Motion of it, and
the Flame is altogether supported by a continual
supply of this Matter, just as a River which never
diminueth the same numerical River, because fresh
waters are always succeeding in the room of those
which run away.

To give an answer to all the Reasons here re-
cited, we say that the Reason why Respiration is
easier, or more frequent in violent Exercises, is
not from the loss of the Spirits, and much less from
the dissipation of the *Nitre*; but it is because in all
such Agitations Respiration is less free, and more
constrained.

As to the motion of the Muscles we shall shew, that
it doth not proceed from the mixing of the *Sulphur*
of the Blood with the *Nitre*.

The great Subtily of the Spirits, and their dissipation do not any ways prove, that they are formed of the *Nitre* of the Air, we every day see other Bodies which are easily dissipated, which contain no *Nitre* in them; and tho' we cannot do without breathing, this doth not proceed from *Nitre* which is contain'd in the Air, but from the Motion it continueth in the Blood by its Spring, as we have often said before.

If those Animals which are placed in a *Vacuo* do fall into Convulsions, this cometh not from want of a *Nitre*, but it is because, by pumping the Air from the Machine, their Blood being multiply rarefied, there remaineth no gross Air, to resist the Effort of that which is in the Blood; but so happeneth, that in pumping out the Air from the Machine, the Air which is in the Blood of the Animal doth also come out with it, the Humours will be no longer rarefied, the Animal instead of swelling will become flat, just as if it had been put in a *Pneuma* because it will be squeez'd together by the Spring of the Air which remaineth in the Machine, for it always remaineth a little of it: This we found by Experience, at the House of an able Enameller, who having put a great Rat in his *Machina de Vacuo* having pumped out the Air, we were much surprised to see that the Rat, instead of being swell'd, was grown very flat.

Mr. Hubertus.

Phthisical or Consumptive Persons, and all those who are Weak-breasted are feeble and languish because their Blood is not disposed to furnish Animal Spirits enough. The Plague and pestilential Feavours do not any ways shew, that there is *Nitre* in the Air: For all the *Phenomena* of these diseases may be explain'd, without supposing that Animal Spirits are any ways altered or affected by *Nitre*, since the Ravage and Destruction which the Plague makes, proceedeth purely from the sharp arsenical Salts which one hath breathed in. It is these Acids of the Air which coagulates the Blood and the *Lympha*, and which causeth those Spots and Carbuncles, and all other Symptoms of the Plague. All this cannot happen, without effecting or disturbing the *Genus Nervosum*. In fine, the quick dissipation

of the Spirits doth not any ways prove, that they are composed of *Nitre*; for the reason why the Spirit is easily dissipated is this, *viz.* That their Particles are very small, and always in Motion, so that they are distributed into the Nerves of the Organs of Sense, were they not succeeded by a fresh Supply, they would be soon dissipated. But let us also suppose with *Mayow*, that there is much Salt in the Brain, and no Sulphur, and that from thence it is more difficult to be impregnated with the *Aereal Nitre*, yet this will not hinder the Brain from imbibing the Nourishment of the Blood, or any other Body of a different Nature from that of Sulphur, thus the Spirits will not retain the nature of *Nitre*, as this Author would have it.

Some believe, that the Spirits are *Sulphurous*, and *Mr. Boyle* says, that they are of the nature of *Sal Armoniack*. *relli.* All this doth not afford us a clear Idea of the Spirit, for excepting their Subtlety, which is the cause of their being so soon dissipated, we shall find, that they have no affinity at all with these Spirituous Liquors. The Spirits are too *Volatil* to be sensible, to be heavy, or to have any such thing, as Colour or Taste, &c. Tho' a Modern Author hath maintain'd, that the Spirits are sweet, and of an agreeable smell, and that Saltiness, Acidity, Bitterness and ill smell, are foreign Qualities, which are never found in the Spirits, but after they are degenerated from their natural state: He would have been more in the right, if he said, that the Spirits had none of those Qualities, because in supposing any sweetness in the Spirits, any Thing we eat would be sweet, and we should not be able to distinguish the Taste of any Thing; if the Spirits were sweet, as he supposeth, we should not be sensible of any ill smell, unless the objects contain'd those Qualities which were natural to the Spirits, and introduc'd strange ones in their places; in such a case, we do not apprehend, how the Spirits could recover their first sweetness with their natural smell.

They say, that this is one Argument, that the Spirits have some Affinity with the Spirit of Wine, and Volatiles, that all Spirituous Liquors recover one in their naturalness and Swooning, since as soon as one smells

leth to it, or that the Nostrils are rubbed with it, or that one take some drops of them in the Mouth, one is insensibly restor'd from that weakness. tho' all Spirituous Liquors do bring those to themselves, who fall into those fainting Fits, it is not these Liquors are converted into the substance of Spirits, as some do maintain; for the small time which these Liquors work their Effect, sheweth very well, that they are not mix'd with the Blood, in order to go to the Brain. Besides so small a quantity of spirituous Liquors would not be enough to restore the Forces that were wasted or spent, tho' it is turned into Spirits; those Volatile Liquors then needs act otherwise.

We daily observe, that in crying loudly at the Ears of those who faint away, or in closing the Hands, rubbing them, or casting of cold Water on their Face, or in fine, by Cupping of them, they come to themselves, as well as if they had taken some of these Spirituous Liquors. Now doth one of these means furnish Matter for the Spirits, one is so void of Reason, as to imagine any other Thing, since all that hath been used in this case doth only irritate the Nerves, by which the Spirits are soon put into motion, and this motion being begun in the Organs of the Senses, the Undulations or shiverings of it will reach even to the Centre of the Brain. There is more reason yet to believe, that the most Volatile Part of the Liquors which are given to People in this case, doth penetrate the Nerves of the Tongue, as well as those of smelling, but chiefly the large Orifices of the Membrane of the Throat, where mixing it self with the Spirits, it communicates a motion to them.

Willis.

Some have also been perswaded, that the Substance of the Brain is impregnated with a quantity of *Sale Ammoniack*, which is sensibly enough perceived by its disagreeable smell, and which is not perceived in the *Medullarie* substance of the Brain. In fine, that this Ferment is of great use for the preparation and Exaltation of the Spirits. But there is nothing of Truth in all this, the Brain hath its particular smell belonging to it, as well as other parts of the Body have theirs, and it

at any time swelleth musty, it is only then it beginneth to be corrupted, for of all the Parts of the Body, the Brain is the soonest corrupted. If we suppose the barky Substance of the Brain filled with a *Sal Ammoniack*, it would not therefore follow, that the mixture of this Leaven with the Blood, would be capable of making Spirits, no more than that the smell of the Stomach, which is so disagreeable, doth contribute to the perfecting of the

There's an Author, whose Thoughts are very different and remote from those of *Willis*: He assureth us, that the Spirits are nothing else, but the more acid Parts of the Blood, which proceedeth from the Air taken in, in breathing; we confess that the most volatile Parts of the Air do much contribute to the forming of the Animal Spirits, but it is not because the Air is acid; for if it any thing contributes to the production of the Spirits, it is because the Particles are a kind of spring, and that these little spirals being join'd to the more volatile Particles of the Blood, compose a Spirituous Matter, which is call'd Animal Spirit.

Mr. Pafal
in his Treatise of the Ferments of human Blood.

This Author proveth the Acidity of the Spirits in three Experiments. 1st. If one tasteth the *Lympha* in the Ventricles of the Brain, we shall find it acid, it fermenteth with the *Oil of Tartar*. 2^d. If we put a little of the Brain which is corrupted into Water, it fermenteth, just as if you had mix'd Leaven with it. 3^d. The Liquor which droppeth from the Water Nerves, fermenteth when it is mix'd with *Yeast*. In answer to the first Experiment, we say, that this *Lympha* hath been taken out of the Ventricles of the Brain of some dead Carcass, where it became Acid by Fermentation, since the *Lympha* in its natural state, is always as sweet as Water. But suppose the *Lympha* of the Ventricles was always acid, it would not communicate its Acidity to the Spirits, according to their Opinion, the *Lympha* is nothing but a pure Excrement. It is no wonder, that a little of the Brain that is corrupted, should raise the Mass or Dough, because the Brain when it is corrupted, may also become Acid, as many other things do. In fine, tho' there floweth something

of Liquor from the great Nerves, we must not imagine, that they are the Spirits which flow off in this form ; but this is the *Lympha* of those *Lymphatic* Vessels, which are spread thro' the great Nerves which might have turned sour, and so may turn when mix'd with *Alkali's*.

Mr. Willis, and Mr. Wicussens.

As the Spirits are extraordinarily subtle, therefore some Authors, who give them a kind of Vehicle retain them in the Body of the Animal. They have supposed a certain Juice which they call *Nervous*, which by means of its Fluidity conveyeth the Spirits into all the Parts of the Body, and by its viscosity hampers them, and hindreth the dissipation of them.

Mr. *Wicussens* in his *Neurography* (which is a Treatise we cannot value too much) calleth the Liquor of the Brain and the Nerves a *Lymphatick* Juice. He saith, this *Lympha* consists of two Parts, the one which is moist and gross, the other which is more subtle; that the first is, (as I may so call it) a sweet Dew, which is poured out into the Brain and Nerves for their Nourishment, and that the Animal Spirits are formed of the more subtle Part of the *Lympha*. The Arguments which the Champions of the *Succus Nervosus* insist on, are these following. 1st. If the Spirits had no kind of Fetters to retain them, they would be presently dissipated, but the moisture of the nervous Juice retaineth them, and putteth a check to their speedy dissipation, even in a manner as Gunpowder, which hath tarred and wet, will not so soon take Fire. 2^d. The softness of the Nerves, their Flexibility, their Humidity prove the Existence of a Nervous Juice; doth there not flow from Tendons and Nerves that are cut, a certain Liquor which thickeneth when it is put over the Fire, like the White of an Egg? 3^d. The Brain and the little Brain are composed of two kinds of Substances, one which is Glandulous, and called *Corticale* or *barkie*, the other *Medullaris*, or of the Substance of Marrow, which is white, and which is nothing but the Excretory Pipes of the Glandules of the Brain. Now if the Glandules in other Parts serve for the separating of some Liquor, why should not those which are in the Brain serve for the same purpose?

pose? They must needs filtrate or strain off the
 ous Juice, which will flow from the small
 reads, or Filaments of the white Part, into all the
 ves. 4th. We may add here also the Arguments
 an able *English* Author who saith, That the Blood
 composed of certain Branchy and viscous Particles, *Colo.*
 ch are yet too big to be insensibly divided, and
 being thus strain'd in the Brain, it will still re-
 sistence enough to form a Liquor which
 easily pass thro' the soft and greater Pores of
 Brain.

Tho' all these Reasons seem to prove the Being of
acus Nervosus, yet there are two Experiments
 ch entirely destroy this System. 1st. The Nerves
 er swell above the Ligature, as we have shewed
 re. 2^d. There floweth nothing from them
 en they are cut. It is true, that there is no cut-
 of the Nerves, without cutting at the same time
 Lymphatick Vessels which are diffus'd all over
 n, since the Lymphatick Vessels have their seve-
 Branches in the Membranes of the Nerves, as
 as in the Membranes of the Veins, or other Vessels
 that carry the Blood. They answer the objecti-
 which is form'd against them, from the Liga-
 on the Nerves, by saying, that if the Nerves
 ll not above the Ligature, it is, because the Juice
 he Nerves is very subtle, and that the Nerves
 being tyed are spoiled or hurt, which causeth a
 opation of the Spirits. They add, that after
 had made a Ligature on the Nerves of *Willis.*
 mals newly born, they have observed a swell-
 above the Ligature, which as they say, was
 ly occasion'd from this, that Liquors of
 ng Animals are more viscous, and not so
 dissipated, as they are in Animals which are
 er.

To avoid this difficulty, some say that the moti-
 of the nervous Juice is neither continual, nor
 etuous, but that the course of it is gentle and in-
 rupted, and that it is determinated by the At-
 tion of the Similary Parts, so we must not be
 rified, that the Nerves swell not at all upon a
 ture, since the Attraction is thereby interrup-
 They add also, that in the Experiment on a
 Living

Living Animal, the nervous Juice hath already fed into the Parts before the Ligature was made, and that it is presently receiv'd into the Lymphatic Vessels of the Nerves.

These are the Answers which they return to those who oppose this nervous Juice, but all the Arguments which they produce are too weak for their defence. When they say, That the Nerves are spared by making any Ligature on them, and that the nervous Juice is thereby dissipated, we cannot conceive that this hurt can any ways produce any Effect, because by tying a Pipe or Conduit that is full of Liquor, the current of it is stopped, there must needs be a swelling in the Pipe above the Ligature. Now if the Nerves swell above the Ligature in those Animals which are newly born, is it not so in other Animals that are older? They will answer, that it is because their nervous Juice is thicker and gluy and viscous; but have all young Animals their nervous Juice equally viscous? Besides, it is well known, that the Juice of old Animals is also thick and gluy, which render their nervous Juice also thick, so the Nerves would be as soon swelled in old Animals, as they are in those which are young.

As for that Attractive Vertue which some suppose is in the Parts for the determining the course of the nervous Juice, it is ridiculous to mention any such Thing in this Age. We do not believe that in tying, or cutting a Nerve, the Spirits are diffused into the Part before the Ligature is made; but let us suppose with them, that it were so, how cometh it to pass, that the Nerve is not swelled by a fresh Supply of this Juice, is it impossible to be repaired when it is once flow'd out? Let them tell me then plainly without any Elusion, why a Nerve upon a Ligature doth not swell at all? Why nothing drops from it after it is cut? For the small quantity of the nervous Juice, the little motion it hath, and the smallness of the Branches of the Nerves and their windings, cannot hinder them from being swelled, because all these Circumstances are sufficiently overbalanced, by the long time that the Liquor remaineth there, provided it be a sensible Liquor which floweth thence. But will they say, that the smallness of the Nerve

their windings are not enough to hinder the
 of this nervous Juice? No, all these Obstacles
 not stop the course of a Liquor, supposing that
 Animal Spirits do form any such sensible Liquor;
 use that which floweth must needs be gathered
 little and little in the Nerves that is tied, and this
 must needs be sufficient at last, to cause a swell-

We see then from all that hath been
 that what passeth into the Nerves, is not
 sensible Liquor as they would have it; since
 Nerves must needs be swelled after a Ligature,
 something would be seen to drop thence when
 are cut.

Besides, if by chance, one seeth that the *Lympha*
 eth in the Wounds of the Nerves and Ten-
 s, or that the Nerves come to be swell'd after a
 ture, their swelling doth not proceed from
 inward Substance of the Nerve; but it is de-
 ed from the Veins or *Lymphatick* Vessels which
 spread all over its Membrane, as we have
 already observ'd.

CHAP. II.

*Of the Forming of the Animal Spirits***Argentier.**

ALL the Physicians agree, that the Animal Spirits are form'd in the Brain, yet we must here except one particular Author, of whom we said something in another place; he will have it, that there is but one Spirit which is call'd *Vital*, which is spread thro' the Mass of the Blood. We have answer'd his Arguments in the precedent Chapter. The Animal Spirits are nothing but the Separation of more subtle Particles of the Blood, which rise up to the Head by the *Carotides*, and the *Arteriae Vertebrales*, and are strain'd thro' the *Cortical Substance* of the Brain.

Moesius, Barbatus.

There are some Authors, otherwise considered enough, who raise an idle Dispute about the Making of the Spirits. Some say, that they are made of the red part of the Blood, others will have it, that they are form'd of the *Lympha*; because if they are form'd of the red part, as the first would have it, they would needs be red; thus the Spirits, for Example, which pass into the optick Nerve, would represent the Objects red. They insist also, by saying, that Insects which have no Blood, are yet very active and nimble, which must necessarily proceed from Spirits.

But what signifieth this idle Speculation? Since the Spirits are neither made of the red, or the white part of the Blood.

To form a just Idea of them, we must conceive them to be a certain lively and penetrating Substance, which is separated from the Blood in the windings of the Glandule of the Brain. Besides, it must be very weak, to imagine that the Blood which is spread into the Brain, and into most of the other

of the Body doth remain there under a red form. Example, in the Tendons, the Gristles, the Nails, the Hair, the Horns, doth not the Articles of the Blood appear under a different colour, according to the different Textures of the Body. Do we not see that all the parts of the Body are red, but of a different Colour! Some are white, some fine, of several colours, as the Hair. We see the same Thing in Plants, the Sap, which (may so say) is nothing but Water, puts on different Colours, and different Consistences, according to several *Philtres*, it passeth thro', thus in the Bark, in the Wood, it is hard; in the Leaves it is soft and green; in the Flowers it is sometimes red, and sometimes of another colour, forming an abundance of admirable shadowings: In fine, this same Sap is in *Liquorish*, bitter in *Worm-wood*, spirituous in *Aromatick Plants*, &c. This natural *Proteus* assumeth so many different forms in its first state, is nothing but Water, impregnated with active Principles. Moreover the *Analysis* of the Blood destroyeth the colour of it, since no red remaineth in it after its distillation.

We do not believe that the Spirits are formed from the grossest Vapours of the Blood, which rise to the Head, as some do imagine; nor that they are the subtle part of the Blood, which riseth to the Head, whither it is carried there by that which is finer, than that which descendeth to the Lower Parts; or whether it is separated from the grosser by passing into the Outward Glandules of the Head, as well as into those of the Neck, called *Jugular Glandules*, and into the *Parotides*, or into the *Salivary Glandules*, as the *Glandula Pituitaria*, and into the small Glandules of the *Plexus Choroides*.

The Spirits are not formed of the Vapors of the Blood, since the *Carotides* and the *Arteria Vertebrales* carry the Blood, which is equally Spirituous. The Blood floweth out of the left Ventricle of the Heart, and is determined to go rather to the Head, than to the Inferiour Parts, because its Determination proceedeth neither from its lightness or heaviness; but from the Impression it receiveth is wholly derived from the Heart, which driveth it indifferently into all the Arteries.

Arteries ; for we must not imagine that the Arteries which go to the Head, are perpendicular enough to make the Blood mount thither thro' its lightness, but the Trunk of the *Aorta* is not just there where it leaveth the Heart, divided into these two Branches, the Ascending and Descending Branches, as it is commonly represented in most Anatomical Treatises, but before the *Aorta* is divided into these Branches, it formeth a kind of an Arch, and before that bending it is divided there where the *Axillares*, the *Carotides*, and the *Vertebrales* do flow out.

The *Lympha* which is strain'd thro' the Outer and Inward Glandules of the Head, doth not proceed from the Blood's being immediately carrying the substance of the Brain, but this *Lympha* comes from the Branches of those Arteries, which are in these Glandules: After that this *Lympha* hath thus strain'd; the Lower Branches of the Veins carry it back again to the Jugularies, in order to its circulation, and that which hath been separated in the *Parotides*, floweth into the Mouth by the Salivary Conduits, as well as the *Lympha*, which cometh from the *Sublinguales*, and all the other Fountains of Saliva or Spittle.

As the Marrow of the Back-bone is of a Substance much like that of the Brain, and the little Brain *Cerebellum*, that is to say, that being composed of a Ash-colour'd part on one side, and a white part on the other, there must needs be a filtration, and distribution of the Spirits in the Marrow of the Back-bone, as there is in the Brain. Large Branches of Arteries are spread all over the Marrow and Nerves that proceed from it. If one cuts the Marrow of the Back-bone longways, one may perceive one of a Cortical Substance, and another of a Medullary Substance, which are situated alternatively one on another, and is what we commonly call Channell'd Bodies, which are thus formed. The Trunk of the *Medulla*, which seemeth to be Fibrous, hath also, in the middle of its Mouth, this Ash-colour'd part; the Capillary Branches of the Arteries and Veins are there lost in it. The *Medulla Spinalis*, hath been always call'd *Cerebrum*.

Corpora
Striata.

a lengthened-brain, because of its structure ;
 to speak more properly, we may call it the Brain
 upside down, because in the Marrow of the
 bone, the white part is uppermost, and the Ash-
 coloured part is undermost. There are also, in the
 bow of the Back-bone, certain Veiney Cavities,
 ere are in the Brain.

sides the more active and refin'd Particles of the
 l, which are strain'd in the Barky Substance of
 rain, the Air which we suck in, affordeth good
 of matter for the forming of the Spirits ; for
 mixing it self with the Blood in the Lungs, and
 ming to the Heart, it is afterwards driven out to
 the Brain. The communication of the Air
 the Spirits, is proved by these Experiments.
 Example, the little knobs of the *Medulla Spi-*
in the Silk-worm, do serve for the same use as
 cortical or Barky Substance of the Brain ; all
 branches of these *Protuberancies* are derived from
Vespa Arteria, and the Air passeth immediately
 these Gristles into the Marrow, in order to
 the Animal Spirits with the other Liquors which
 strain'd in the *Medulla Spinalis* of the Silk-

hen we say that the Air goeth, or contributeth
 the composition of the Spirits, we do not mean,
 an any one imagine, that the Air passeth into the
 thro' the Nostrils, as the Antients, and many
 Moderns have pretended. They all generally
 id that the more subtle part of the Air immedi-
 passed from the Nostrils to the Brain, in order to
 matter for the Animal Spirits. But it hath
 demonstrated long since, that there passeth no
 from the Nostrils to the Brain, and that the Ani-
 mals in the *Fetus* are made without concur-
 of the Air, as also in Fishes, tho they yet re-
 a little Air also ; the *Fetus* from the Blood of
 Mother, and the Fish from the Water.

fore we engage our selves too far into these par-
 ticulars, let us see what might dispose them to be-
 lieve that the Air pass'd thro' the Nose into the Brain ;
 being but certain Odours or Smells, which pure-
 ly consist of these Saline and Sulphurous Particles
 which are scattered in the Air ; If they are very

Hippo-
 crates, Ga-
 len, Ve-
 sali. Lau-
 rentius,
 Bauchi-
 us, Sen-
 nertus,
 &c. Bur-
 rhus in
 his Letter
 to Bartho-
 lin. Fra-
 cassati.

strong,

strong, for Example, as the Spirit of Wine, or *Ammoniack*, they will soon bring Apoplectick, or leptick Persons to themselves; they will recover hitherto stolid Women of their Vapours, which thing they, cannot be otherwise occasion'd than from the Air, which they Breath in, which passeth thro' the Brain, and being mix'd with the Spirits, it is strengthened and more invigorated thereby. And we have observed, that in most Insects the Air hath an immediate Communication with the Brain, and the *M. Spinalis* by means of the *Aspera Arteria*, to which also this must be added, that in great Birds the Nostrils open into the Brain, as in the Eagle, Goose, and other great Fowl. The *Os Cribriforme* sieve-like-bone in these Fowl, is not bored through with little Holes, as it is in Man and other Animals, but it hath one only Orifice, directly over against the outward Orifice of the Nose. In fine, they say, that the Animal Spirits cannot subsist without the succour or Succour of the Air, because the Blood, of itself is not sufficient to repair their loss.

Borrichi.
us.

In the mean while all these Arguments do in many ways confirm the Opinion of the Antients. It is certain that certain Odours recover some Persons from Faintness and others from Convulsive and Epileptick Fits, and this doth not therefore happen, because the Air, but because the Odours do penetrate into the Brain, and affect the Nerves, but because the Air which we breathe passeth from the Nose to the *Aspera Arteria*, and from the Lungs to the Blood, to which it giveth Spring and Vigour. The Air cannot pass thro' the Nose without losing, or being clear'd of its Odour, nor without affecting or shaking the Organ of Smelling; which raiseth certain Undulations or Tremblings in the Spirits, which immediately reach to the *Centrum Ovale*. Now what that *Centrum* is, we will shew, when we come to Treat of the Inward Senses.

These Undulations is that which determines the Spirits to flow into the Organs of the Senses; thence we see, that the Spirits are refresh'd in many ways. First, they receive succour from the Air which they suck in, because these odours do effect the Organs of Smelling; they in fine, are succour'd by the

passeth afterwards into the Lungs, which by it self with the Blood, restoreth to it the which it had lost, as I may so say, and this Force, which all the Particles of the Blood from the Air, disposeth them to be more strain'd, and to give a motion to the Spi-

to the Nerves, some have thought that they suck up something from the Humours of the parts, that these Liquors return'd afterwards to the

They say, that the Nerves of the Tongue, those of the Stomach, do immediately receive small matter of a Nourishing Juice, the first the Food we take, the other from the Leaven of the Stomach. These are their Arguments. 1st. In Abstinences, and great loss of Spirits, the Brain faileth to exercise its functions, because the parts of the parts drink up their nourishing Juice, which is afterwards carried to the Brain, in order to be chang'd into Spirits. 2d. As soon as any one hath drunk any Spirituous Liquor, he is presently recovered from his Fainting or weakness, because the Volatile Particles of it pass into the Nerves, without entering the Blood. We have explain'd elsewhere, after what manner these Spirituous Liquors do Operate, what the Effect of cold Water flung in the face of those who Faint away, is, we have shew'd that it proceeded from the shaking of the Organes of the Nerves, which gave an occasion to the parts for renewing of their Undulations or Shivers.

We are not a little surpriz'd, that Dr. Willis should think that the Nerves brought back the Humours from the Parts to the Brain, not only in the State of Health, but also during sickness: For he looketh on the Nerves of the Spleen and the *Matrix*, as so many Pumps to suck up ill Humours, which afterwards stir up horrible Symptoms; but these Accidents may be otherwise explain'd, even in long Abstinences, there remaineth some Force, not that the Nerves receiveth any thing from the Nerves, but because the Nourishing Juice, by abstinence sowreth, so that it giveth still some small motion to the Nerves,

Nerves, which is sufficient to keep up the motion of the Spirits in the Brain.

In Diseases of the Spleen and *Matrix*, &c. the rising Liquor of these Parts grow sour, from Obstructions in those Parts; thus they irritate, violently shake the Nerves; this putteth the Spirit into a violent impetuous motion, which passeth to the Brain, by the Communication of Nerves.

Tho' there is a Communication of the Air to the Brain, and the *Medulla Spinalis* of the Silk-worm and other Insects, this is no Argument, that they maketh the Spirits; for it is well known, that the Branches and Gristlelike Parts of the *Aspera Arteria* of the Silk-worm and other Insects, are not only below the Brain, and the *Medulla Spinalis*, but even pass thro' the Heart, Stomach and Guts, for there is no *Viscus* or Bowel without its Lungs; whence one may conjecture, that besides the subtle Part of the Air, there is also a grosser to support, or keep up the Life of the Animal, perhaps may examine this Point more at large another time.

The *Apophyses Mamillares* of the Brain in Birds have no Branches, they make a Pipe, like the end of a Bag, which exactly filleth up the Hole of the *Os cribrosum*, so that it is impossible for the Air to pass from the Nose to the Head: In Man and in other Animals the *Os cribrosum* receiveth many Branches of the *Vas Olfactorius*, which pass thro' all the little Foramina of the *Os Ethmoides*, in order to form those narrow Tufts of the Membrane of the Nose, so that the Air is so well stopped, that there is no passage at all for any thing. But suppose the Air passeth from the Nostrils into the Brain all that would follow from it, is this, that the Air would somewhat dilate the Ventricles of the Brain, but it could not enter into the *Cortical*, or barky Part thereof, for this is the proper *Filtre* or strainer of the Spirits. As to the Loss of the Spirits we answer, that they are sufficiently repaired by our Food, and by the Air we suck in, which is mix'd with the Blood. Several Arteries are spread thro' all the *Labyrinths* of the bony substance of the Brain. All these Vessels

to furnish the Brain with Blood for the filtrating
 straining of the Spirits. The *Medullary* or Mar-
 ry-part of the Brain is not without its Vessels, but
 are incomparably smaller, than those of the Ashy

is the Opinion of a great Man, that the Animal *Steno* in
 actions do not only depend on the Brain, for he *his Tractise*
 will have the *Medulla* to be the first Source or Foun- *of the Can-*
 of the Spirits, which he maintaineth. 1st. *Be-nis Kar-*
 of Fish have scarce any Brain at all, nay some of *karias*
 have nothing but Oil in the little Cells of the *which is*
anium, and this is that Oily Liquor, which is im- *the great*
 verly called *Sperma Ceti*, the use whereof is so *Sea Dog.*
 known in Physick. 2^d. The Marrow of the
 back-bone in Fish is very considerable, from whence
 proceed abundance of great Nerves which are di-
 stributed into the Muscles, which compose in a man-
 ner all the Body of the Fish; For we must look on
 Fish, as a Boat, whose swiftness in passing thro'
 Water, is purely to be ascribed to that infinite
 number of Oars which are on both sides of it.

We must observe, that the Marrow of the Back-
 bone in Fish is every where of the same bigness, and
 that the bulk of it is not less at the *Os Sacrum*, as it is
 in Man, and other Animals. 3^d. The Marrow of
 the Back bone in Beasts of burden, is very great in the
 parts of the Loin's. 4th. In the *Medulla Spinalis*
 of Birds, there is a great Rhomboidale Cavity on the
 one side of the Loins, which much resembleth the
 fourth Ventricle of the Brain in four Footed Animals.
Perrault's Thoughts on the use of the Venti-
 cles in the *Medulla Spinalis* of Birds, are particular
 enough; he saith, that this Ventricle is as necessary
 to them, because they void more Excrements than
 other Animals, from the force and continual motion
 of their Wings, the strong Action whereof wasteth
 a greater quantity of Spirits.

In answer to these reasons of the Learned *Steno*,
 we must observe, that in depriving the Brain of its
 function, he, at the same time, divests the *Medulla* of
 its Function also, which is what he doth not reflect on;
 if the *Medulla Spinalis* serveth for the Filtrating
 of the Spirits, it is because, like the Brain, it is com-
 posed of an Ash-colour'd part, and a part that is all
 white.

white. Besides the Ash-colour'd part which is call'd *Cortex Cerebri*, doth not only appear on the Surface of the *Medulla*, but is equally mix'd thro' all Inward part, and then it is no longer to be call'd *Pars Corticalis*, tho', for all that, it is nevertheless Glandulous; this Substance appeareth very visible in the lower parts of the *Medulla Allongata*. After this, we must not be surpris'd to find that there is a greater quantity of Spirits filtrated in the *Medulla Spinalis* of Fishes and Insects, than in their Brains, since they scarce have any, and that the *Medulla Spinalis* in them serves them instead of a Brain.

The Ancients constituted several kinds of Spirits, which they have call'd Animal, Vital and Natural, and there are some Modern Authors for a fourth kind, on one side all these differences are trivial and useless. Some will allow of but one Spirit which they call Animal, because it is the cause of all the motions of Animals. This spirituous Substance is separated from the Blood thro' the Glandules of the Brain, which is done at every stroke, or impulse of the Heart, which sendeth Blood to the Head, that is charged with the more subtle Particles of that Air which hath receiv'd from the Lungs.

Whereas the Air hath no close Union with the Blood, and that the Particles of it, thro' their particular Figure, are the better disposed to pass thro' the windings of the Glandules of the Brain, they easily insinuate themselves there, they carry along with them the most active and penetrating Particles of the Blood; and thus being forced from the Blood, they are thereby more qualified to form that which is call'd the Animal Spirit.

Let not any one imagine here, that there needs any *Transmutation* here for changing the Blood into Spirits, it is enough, as we have now observ'd, that the more subtle part of the Air and the Blood be filtrated in the Brain; and even, tho' in Animals which are just forming, the Brain is not entirely organized or perfected, yet without doubt, there are some Spirits, since there is a necessity of some noble Architect to dispose, and order all the work of the Body of an Animal, now this Architect is the Spirits of the seminal Matter of the Egg, which are (as I may say)

quicken'd or excited by the Spirits of the Seed
 the Male, which modify all the Parts, by open-
 the Pipes and little Bladders to dispose them to
 give that Nourishment which is already prepared
 them within the Membranes of the *Embryo*, since
 Eggs of Animals, as well as those of Fowl, have
 their white and their yellow Part, which yet
 not in that quantity, as it is in the Eggs of Fowl.
 Neither must we have any recourse to a Leaven
 the forming of the Spirits, we have demonstra-
 that there is no Ferment in the Brain, and we
 said, that being kept for any time it contracts a
 strong smell, which is always an effect of its Cor-
 ruption.

There are two things which contribute to the
 forming of the Spirits. *First*, the motion of the
 Blood, which is carried with great swiftness to the
 Brain. *Secondly*, The motion of the Brain, the Blood
 first mounteth to the Head with Rapidity, but its
 force is presently check'd, because the Arteries of
 the Brain before they enter into the substance of it,
 form a kind of Network, in which the impetuosi-
 ty of the Blood is retarded, so that it passeth into the
 Brain only by little and little, and not as an impetu-
 ous Torrent, which would ruin all. These *Plexus's*
 which are spread over all the barky substance, and
 which descend even into the *Labyrinths* of the Brain,
 are so artificially made, that there is not so much as
 the least Communication from the *Carotides* on one
 side, to the *Carotides* on the other, or from the *Verte-
 brales* to the *Vertebrales*, but the *Carotides*, by way of
 Anastomosis, do open into the *Vertebrales*, so that
 one maketh an Injection of Wax into one of the
Carotides or *Vertebrales*, it passeth into all the Bran-
 ches of the Arteries of the Brain, which it equally
 filleth up. Without doubt, Nature hath made use
 of this ingenious Mechanism, that the Brain, as the
 famous *Willis* observeth, should never want Blood,
 but be watered, or bedew'd with it from all Parts,
 for there is no place in the Brain which doth not
 equally receive it.

The Blood of the Arteries being spread into the
 barky-part, the subtle part of it must needs pass thro'
 the Glandules, because it is continually driven by
 fresh

fresh Blood which cometh to the Head. Now all the Particles of the Blood, like so many Wedges driven on each other by their motion, those which are too big to pass into the Pores of the Glandules, remain there as useless matter, unfit for the Composition of the Spirits.

The motion of the Brain, as we have said before, doth much contribute to the separation of the Spirits: this motion is perform'd thus, we shall observe, that the Arteries are distributed in the Brain, after three several Manners, either they are inclos'd betwixt the Membranes which cover them, where they are all naked, and disengag'd from the Membranes, where they form the *Rete Mirabile* of Animals and half the *Plexus Choroïdes* in the Ventricles, or else they spread into the *Medullary* substance of the Brain, to which they penetrate, or else they are free from this hard Membrane altogether.

The Arteries of the Membranes of the Brain are the biggest, those of the *Rete Mirabile* and the *Plexus* are much less, but those of the *Cortical* substance are so small, that they are hardly perceiv'd, unless it be by means of the drops of Blood which fall there when they are cut. The thinness, perhaps, of the fine delicate Membranes is the cause why they are so little visible. There are Veins as well as Arteries betwixt the two Membranes, there are some also floating in the Ventricles, which compose the other half of the *Plexus Choroïdalis*.

After we had thus examin'd the disposition of the Vessels of the Brain, we have observ'd, that the Arteries from hard, as they were, become small and loose before they enter into the Brain, therefore they are capable of a greater Dilatation there, than in any other Parts of the Body, for having not that hard nervous Membrane in the Brain (as we have observ'd) which they have else where, by the Spring of which they resist that impulse the Heart maketh, for driving of the Blood with more force into the remotest Parts, and making not that resistance there, which they do elsewhere, they beat violently on the Substance of the Brain, just as it happeneth in an *Aneurisme*, where there is an extraordinary Pulse, but there is nothing extraordinary in the motion of the Heart.

heart, and other Arteries at the same time. For this great Pulsation in the Tumour of an *Aneurisme* proceedeth purely from the Dilatation of the Artery, which hath rendred it much finer than it was. Not being able then to support the strong Impulse of the Blood, it must needs have a sensible beating. The Arteries of the Brain also being small, the whole Mass of them must needs be raised up at each Pulsation of the Blood. Now as the Brain must needs fall down again afterwards by its own heaviness or weight, when that Impulse of the Blood is passed, the Glandulous substance of it is strongly squeez'd together; and the Blood which was got into the Glandules, is driven thence as from a Spunge which one squeezeth with one's Hand. In fine, the more subtle Part passeth into the Excretory Pipes of the white Part.

Most Authors are of Opinion, that whilst the Spirits are separated or strain'd, the superfluous Serosities flow into the Ventricles of the Brain. But we should be first assured, whether there are any Humidities in the Ventricles of the Brain, as some have said, that there is Water in the *Pericardium* in its natural state; or it is confess'd, that many Fables have been invented about the Liquor of the *Pericardium*. They say the Wounds of this Part are mortal, because the Liquor being run out, or dried up, one groweth Hectick, because the Heart is no longer refresh'd, so that the Body must needs be dried up, but if the Wounds of the *Pericardium* have sometimes prov'd mortal, it is not because the Liquor hath flowed out thence, but because the Vessels belonging to it have been

Moreover in the *Pericardium* of Living Animals, there is no Water to be found, nor in those who are in perfect Health. But in opening the Bodies of men who died of Chronical Diseases, or the Bodies of those who were Hang'd, or of Animals which have been strangl'd; it is true, there is always Water in the *Pericardium*, which is more or less, according to the different Diseases and manner of their Death, and in all those who dye of any Chronical Disease, in which their bowels are always full of obstructions, the *Pericardium* is often found full of Water: On the contrary, if the Disease was acute, there is but very

ry little Water in the *Pericardium*. In fine, in all dies which are open'd, there is always found a small quantity of Water in the *Pericardium*; this gave an occasion to the ancients, of believing that it was natural. They have all of 'em publish'd several Fictions, about the use of it. Some have said that it refresh'd the Heart, others have said quite contrarily, alledging, that it serv'd to increase the Heat there as Water in a Smith's *Forge*, augmenteth the Force and Activity of burning Coals.

In fine, others have also said, that this Liquor is of great use to facilitate the motion of the Heart, on the contrary, this would rather hinder and obstruct the motion of the Heart, for it receiveth its motion from the Water of the *Pericardium*, like the Wheels of a *Water-mill*, but we know that the motion of the Heart is perform'd as that of the Muscles is, by the pure disposition of its *Fibres*; and this is an Argument, that this Liquor of the *Pericardium* is altogether destructive, that when it much aboundeth, it causeth such Palpitations of the Heart, as sometimes depriveth the Heart altogether of its motion and occasion sudden Deaths.

Be it how it will, one great Argument they insist on is this, that in violent Deaths, as in those who have been strangled and drown'd: In the first, the course of the Blood is stopped, the Vessels and Wind Pipe being exactly clos'd or press'd together, so that the course of the Blood and the Air being interrupted, all the Glandules are swell'd, the Texture of the most delicate of them is presently broken, by this occasion there is found a little Water in the Ventricles of the Brain, and in the *Pericardium* and moisture everywhere, where there are any Glandules. Now it is well known, that the *Superficies* of the *Dura Mater* is full of small Glandules and *Lymphatick* Vessels, as well as the Membrane of the Lungs, the Pleura, the *Pericardium*, and the great Vessels; so that the inside of the Belly upon the dissecting of a Body is always found moist, because the Glandules of the *Peritonæum*, the *Mesentery*, the *Pancreas*, are all swell'd, which hath caus'd too great a Separation of the *Lympha*. In fine, to confirm all that which we have here said or maintain'd, in the dissecting of the Bo-

who hath been beheaded, there is no Liquor in the *Pericardium*, nor in the Ventricles of the *Heart*, and the other Cavities of the Body remain

sides this is a Point to be determined purely by Experiment, if then you cut up a Dog, as soon as ever fastned to the Table, without making of him any Wound, there is not one drop of Water to be found in the *Pericardium*, it is only moist, as it hath us'd to be, which is demonstration, that the Water which is found in the *Pericardium*, and in the Ventricles of the Brain, is always an Accident arising from the Disease, or the manner of their Death. Physicians will also assure us, that they never find any Water in the *Pericardium* of all the Animals and Creatures which they kill.

Hippocrates speaking of the Liquor of the *Pericardium*, saith it is like Urine in its natural state, and sometimes it is like the Water in which Flesh hath been wash'd, because it is a little bloody. This Assertion of that great Oracle of Physick, doth wonderfully confirm, what we have here advanced; the Water of those who have the Dropsy, is sometimes bloody, which always proceedeth from a considerable obstruction of the Glandules, which on an occasion to the *Lympha*, to tear or break the Texture of the Glandules, and other Vessels that contain any Blood.

We shall observe by the way, that the *Pericardium* is not to be found in all Animals, the Hedgehog, the Mole, &c. have no *Pericardium* at all, instead of that, the Membrane which covereth the Fibres of the Heart is thick and strong, for we observe that the Membranes are nothing else, but Tendons stretch'd out and dilated, which serve to the augmenting of motion.

The *Pericardium* is so fine and small in the Rat and Mouse, that without exact observation, one may be surpris'd, and assert that these Animals have no *Pericardium* at all, as some have thought. But in all kinds of Serpents, this Membrane is very thick, which is very necessary, to promote the motion of the Heart, that it might have strength enough to disperse the Blood thro' the whole Body; for the Heart is so small,

small; in respect of the whole Animal, that the Handles of that Pump had not been strong, the liquor wou'd not be carried far enough. By that it is manifest that the *Pericardium* serveth for a much more important Use, than that of holding a little water, since it is a Muscle, which by vertue of its own Springs, contributes to the motion of the Heart.

In his Letter to the Royal Society of London about the Glandules.

We are of late beholden to Mr. *Malpighi*, for his discovery of the true structure of the *Pericardium*. He saith, That the inward Membrane is strongly polish'd, and very different from the outward, and that there are betwixt these two Membranes certain fleshy *Fibres*, which go spirally from the Base to the Point, as those of the Heart, with Nerves and other Vessels that carry Blood. All the inside of the *Pericardium* is bored thro' with many little holes thro' which a small quantity of the *Lympha* passes to moisten the sides of it. These Excretory Vessels proceed from certain little Glandulous Bodies which are betwixt the two Membranes. In certain Diseases these Glandulous Bodies sometimes grow very big, that they are half the breadth of a Finger. As Mr. *Malpighi* found the *Pericardium* in an Infant Child, that had been dead for some days.

This Glandulous Substance was very thick, uneven or rough, and divided into several small spaces betwixt them, some whereof were filled with a yellowish and hardened Matter, and others were empty of the same colour. The Heart was covered with a Glue like that which was spread all over the inside of the *Pericardium*. This Glue stuck so to the Membrane of the Heart, that it was impossible to separate it, without tearing the Membrane into pieces.

Which is an Argument, that the Water which is found in the *Pericardium*, upon the dissecting of several Bodies doth always proceed from some Disease, which sometimes ariseth to four Pints, as Mr. *Malpighi* saith, he once observ'd in one Body or Case in which same Body there were also at least 8 Pints of Water in the Belly, altogether like that in the *Pericardium*, the Blood was coagulated in the Veins as if some Acid had been injected in it. He observeth also, that he once found the *Pericardium*

ed to the Heart, that there was no possibility
separating it, without tearing the *Fibres* of

the Ancient Physicians have pretended the same
as to the Water that is found in the Ventricle
of the Brain in dead Bodies; they have said that
it is natural, and that this *Pituita* discharg'd it self
at the Mouth by the *Glandula Pituitaria*. They
believed that the Ventricles of the Brain were the
Reservoirs, or Reservatories of the Animal Spirits,
the more refined of the Moderns have maintain'd,
these Serosities would rather contribute to the
Nourishment of the Spirits, and thus these Ventricles
for no such use. It is surprizing, that the Spi-
rits should be so apt to deceive it self in its way of rea-
soning.

Have not all Practical Authors asserted that
Humours gather together in any of the Parts,
extravasated, or to be look'd on, as out of their
proper Vessels? It is then evident that these Humours
we speak of, naturally speaking, are never to
be found in the Ventricles of the Brain, nor in the
ventriculus, unless in some Chronical Disease, in
which, by length of time, the *Lympha* is entire-
ly separated from the Blood, by reason of some Ob-
structions.

There is no doubt of the Use of the Animal Spirits,
well known, that they contribute to all Sensation
and to all motions which depend on the course
of the Spirits, which being diffus'd into the Parts,
contribute to their Nourishment, by keeping their
Pores open, and in communicating a Spring to their
Action. Besides all Filtrations and Digestions are the
easily perfected by them.

They distinguish, or divide the Spirits into such
as serve for sense or feeling, and into such as serve
for motion; they suppose, that those Spirits which
serve for feeling, are derived from the *Cortical Part*
of the Brain, and that those which serve for motion,
are derived from the *Pars Medullaris* of the Brain.
This is an idle impertinent Distinction, since
there is but one Animal Spirit which serveth indiffe-
rently both for feeling and motion: For it is only
the diversity of the Organs which determinateth
the Spirits to make us move, or to make us feel: For
Example,

Example, the Animal Spirit which is carried by the Auditory Nerve is distributed into the soft and hard Part; That of the soft Part is employed on the principal Organ of Hearing; that which passeth into the hard Part, is distributed into several Muscles to all the Skin of the Face, &c. We see then the Spirits serve sometimes to Sensations, and sometimes to Motion, according to the diversity of Organs; and we may even say, that the Spirit is inclos'd in a Nerve, serveth both for Motion and Sensation at the same time. When one pricks one's self, the Pain which one feelth, proceedeth purely from the Undulations or shiverings of the Spirits, even to the Brain, and the motion of the hand proceedeth also from the same Spirits which make the Muscles play.

It is said, that in Palsies one sometimes looses Motion, without losing Sense or one's Feeling; and the contrary, that sometimes one loseth one's Motion, without losing one's Sense. But these *Phenomenas* may be easily explain'd, without supposing two kinds of Spirits; if one happeneth to lose one's Motion, without losing one's Sense of Feeling at the same time, the reason of this is, that the Sense of Feeling, being only an Impression on a Sensible Object, which Impression is carried by the common Sense, by the Motion of the Spirits, in case they are strong enough to make their necessary Undulations, this is sufficient to cause Feeling. In the contrary, to make any Part move, the Spirits must needs have great Force and Motion; they (as I may so say) descend from the Brain, even to the Extremities of the Nerves.

In fine, when we loose our Sense of Feeling, without being depriv'd of our Motion, this ariseth much more from the Fault of the Spirits, as from some defect in the Organs. For Example, when we are blind, this is not for want of Spirits, but it is because the Optick Nerve, the Humours or the Retinae have changed their state and Disposition, the mean while the Eye moveth still as it us'd to, because the Spirits still flow, as they usually do by the third and fourth Pair. So also when one is depriv'd of the Sense of Touching, and that the

Fibres which are under the Skin, retain their Spring: This Loss or Privation, always resulteth from some Indisposition of the principal Nerves of Touching.

Observ'd, that those Parts which have lost their Sensibility, and yet retain their Motion, do not grow lean at all, because the course of the Spirits is not interrupted, the Pipes and little Bladders are still open for the receiving of the nourishing Spirits. On the contrary, when a Part is once deprived of its Motion, it groweth lean and drieth up, because the Spirits can no longer flow there, by reason of the Obstructions, the Bladdery Texture of which is compos'd, falleth flat down, and becometh hard.

They who have lost the Sense of Touching, commonly do become Leprous, and are called Fools. Their Skin groweth hard, the Nails, which are the Organs of Touching, are dried and become callous; which may proceed from the Disease, or else because these poor People, being Fools, often expose themselves naked to all the Inclemencies of Weather.

CHAP.

C H A P. III.

Of the Distribution of the Animal Spi

Since we have already shew'd the nature and Sing of the Spirits, we come now to examine what manner they are distributed to the several of the Body. All the action of the Spirits in natural state, and when we are free from all Pain, purely consisteth in a soft and gentle motion, without any Impetuosity, when an Object maketh a pressure, or toucheth any of the Senses, we do not imagine, that the Spirits in the Nerves are moved at one Jirk from one Extremity to the other; it is enough that the Undulations of the Spirits are convey'd to the Brain. It is no ways difficult to conceive how this motion sensibly passeth from the outward Parts to the Inward, or from the Inward to the outward, since the Spirits are diffus'd all over the *Genus*, and that all their Particles touch each other as in a Line. To explain this Undulation or Sing of the Spirits. Some make use of the instance of an Eel-skin full of Water, there is no squeezing or Sing of it, without raising certain Undulations of the Liquor. In Animals, the Spirits are always in motion, and not one moment in repose; the Brain which is continually strain'd into the Cortical Barky-substance of the Brain, in order to flow in the form of Spirits, into the white Part, continues to pusheth on those it meeteth with in the Nerves, this keepeth up their motion. Tho' these Undulations are gentle, yet they do not long continue the same, because Passions, Sicknefs, Pains, and all extraordinary motions, create an Imperuosity in the Spirits.

Borelli.

It hath been said, that the natural motion of the Spirits was gentle, and their course regular, was necessary to make them contribute to the nourishment and motion of the Bowels, which have no need at all of any great Agitation of the Spirits.

for all Sensation, and the motions of the Muscles. Stronger Undulations are requir'd for their being excited by the Objects and by the Will.

The Spirits move more swiftly in the Nerves, than in the Brain or *Cerebellum*, because in passing thence into the Nerves they come out from a large place into a narrow one, and thus consequently their swiftness encreaseth, accordingly as it is demonstrated in the *Hydraulicks*. But when the Spirits are determin'd by their Objects to run back towards the Brain, their swiftness is then lessen'd, because in passing from the Nerves into the Brain, whose space is very large, in respect of the Nerves; their motion must needs be slacken'd. One may suppose two contrary motions in the Spirits, one proceedeth from the Brain, which giveth them their first Agitation, the other is deriv'd from the Objects which touch up- on the Senses. The natural Spring of the Nervous System, also beateth back the Spirits, by giving them new Undulations, contrary to those they had receiv'd; for it is impossible for the Spirits to flow from the Nerves, without dilating of them in some degree, and this Reflux of the Spirits proceeds from the Spring of the Nerves.

The white Substance of the Brain, which the Ancients call'd the *Pars Medullaris*, because they thought it was all Marrow, is yet of a very different structure from Marrow, since it is only a Heap of little pieces, thro' which the Spirits flow. The *Fibres* of the *Medullary*-substance are visibly perceiv'd in the Brain of Fish and Birds, they are so well distinguish'd from the Ventricles, that they seem to be all white; they are also better discern'd, when the Brain is boil'd in Oil, one may then distinctly view all the little undules of the Cortical substance, because being boil'd in boyling, the Spaces betwixt them are something dilated, and at some distance from each other. After you have taken off the *Pia-mater*, when the Brain is still hot, you must pour a little Ink upon it, and gently dry it in, or wipe it with Cotton. These means the Spaces betwixt them grow so black, that every particular Glandule may afterward be easily distinguish'd. In fine, one Argument to shew, that the ashy part of the Brain is nothing else but

a Heap of the small Glandules, is this, that if part of this Substance happen to petrify, as it sometimes happen'd; these Petrifications do resemble a *Mull-berry*, such was that which *M* mentioneth: This Cortical-substance after it petrified, still retained the natural Figure of Glandules.

The Nerves are form'd from several little Threads which are enclosed in a very strong Sheath, which is composed of the *Dura* and *Pia-mater*. All the *Nerves* are hollow, being also but a continuation of the *Medullary* substance of the Brain, or of the *Spinalis* contracted into small Bundles, and all these little Strings which are deriv'd from it, are invested with the same Coats as the Brain is.

It is now more than an Hundred Years since the true structure was first discover'd. *Volcherus Coiter* in his *Anatomical Observations*, and in his *Chirurgia* demonstrated that the Nerves are nothing else but a Heap or Parcel of small little Threads which derive their Rise or Origin from the white part of the Brain, and as they come out from the *Cranium*, are invested or cover'd, with the *Pia* and *Dura-mater*. This he formerly had observ'd in the *Cerebrum* Nerve, where the little Threads are very few. But we must also know that all those little Threads which compose a Nerve, do also consist of other very delicate *Fibres*, every one of which being enclos'd in a Membrane that is thicker than a Spider's Web. This Membrane is the Production of the third Coat of the *Medulla Spinalis*, as an able Practitioner first observ'd.

Tulpius.

Cent. 1.

Obser. 27.

The Nerves do often grow bigger by the Branches which they receive from the Parts; and the Branches joining together, do afterwards make up one great string, of a very considerable Force, at its leaving of the *Cranium* was soft, and malleable. Some think that the Third Coat of the Nerve is deriv'd from the *Pia-Mater*; others fancy, that they have discover'd its true Origin, because they have (as they say) another 3d Membrane, between the two Membranes of the Brain: Were this Membrane distinctly separated from the two others, it would be something curious, and particular; but this is

Mr. Bidloo
in his *Ana-*
tomy.

since the Brain hath naturally but two Coates
Membranes.

I am apt to believe, that the Author would
impose on us as to a third Membrane; he is too
to have his words question'd. He saith, he
discover'd it in a publick Dissection upon one
had been dead not above three Hours. He be-
with the Demonstration of the Brain, he per-
a very fine Membrane which was free, be-
the *Dura Mater* and the *Pia-Mater*. A very a-
Professor of *Lipfic*, saith he, found the same thing
Body of one who had been Dead fifteen
But tho' this Membrane hath been often
we must not therefore conclude, that it is or-
or common.

Mr. Boul

The Anatomists say, That the Olfactive and
Nerves are bor'd thro', particularly in Brutes.
if one Examineth them narrowly, we may
perceive that there is no such thing, and that
are compos'd, as all other Nerves are, of sever-
small nervous Fibres. It is yet true, That the
Nerves in Animals have a kind of Cavity,
this Cavity is made neither for the carrying of
elements, or Spirits, it is like the end of a Bagg
side of the *Os Cribriforme*.

for the Optick Nerves there is no Cavity at all
we often observe there certain Arteries and
as big as little Pins. It is true, that there
the Optick Nerve pierceth the bottom of the
one may perceive a little bending in, which
a little shade; but this little Cavity is purely
by the little Thread of the Optick Nerves,
are something divided from each other at the
confluence, in order to form the *Retina*, even as
separating the Leaves of a Pink, a small Ca-
may be observ'd even within the Case or Cup

The *Medulla Spinalis* is all Fibrous, as well as the
if you steep, it for a small time, in the Spirit of
or any other Wine, the Marrow which is
in the Joints of the Loins, it is presently di-
of its self into several little Threads, which is
in the Marrow which is in the Joints of the
Tho' the Nerves are derived from the same

Substance, yet some are soft, and others are hard. The most tender of them are distributed to the Organs of the Senses, as the Olfactive for smell, the Optick for seeing, and the soft portion of *Nervus Auditorius* for the chief Organ of hearing. Moreover, as for the Nerves which have more consistency in them, many of them serve for sensation and motion, at the same time, and there are others again which serve purely for motion.

If it be ask'd why some Nerves are hard, and some soft? All Authors are silent as to this point; some have attempted to explain this *Phenomenon* by a final Cause. They say, that sensations are excited only by a gentle shaking of the Nerves, and therefore Nature had made use of soft Nerves; but for Motions, stronger Nerves were necessary, and therefore were stiff and hard, for the better resisting the efforts of the Muscles.

But to say, that some of the Nerves are soft, some hard, for motion and sensation, this is not explaining or opening the State of the Question. What is demanded, what is that which maketh them soft or hard? For we must not imagine that the Nerves broke in violent motions of the Muscles: For Example, the Nerves which are distributed to the Mouth, of the Tongue, of the Eyes, of the Ears, are soft Nerves: This is not to prevent their breaking, for it is well known that the Nerves move with the Muscles, as a Chord which is fastened to a Burden.

Now to know why there are hard Nerves, why there are soft ones, we must Examine them from their Origine, and after they have left the Brain. The first Fibres, just at their coming from the *Medulla Allongata*, are equally soft, but when they are incorporated, and reunited into one string, they may become either hard, or soft. For example, a String will be soft when the inward Fibres receive no Coat from the *Pia Mater*; and hard, when a particular Fibre shall have its particular Coat or Sheath, to fortify it, beside the common Membrane with which they are covered; so that a Nerve may be properly said to have softness, when the Fibres which compose it, are deprived, or have no parti-

Coats, and have nothing to cover them but the common Coats or Membrane. But when the Fibres immediately on their coming forth from the *Medula*, have each of them their particular Coat, Nerve, which is compos'd of them, must needs be so much the harder. In fine, if the Nerves, which go to the Organs of the Senses, are very soft, for this end, that the Objects may make the stronger impression; and if the Nerves, which are appointed for motion, are something harder, this is not to prevent their being broke, as some Authors maintain; it is, that all the Fibres of the Nerve, having every one of them their particular Coats, they may better direct the Course of the Spirits, for the different determinations of the motions. The Nerves must needs be Porous, whether you consider them all entire, or whether you consider only the small Pipes of which they are made; for these small Pipes are nothing else but the extrinse Pipes of the Cortical Substance, according as there are more or less of them in one Nerve, than in another, they will be also more or less Porous, and there is nothing doth more resemble a Cane, than the Nerves.

Some say, that the Fibres of the Nerves are full of certain Marrow, like that of the Pith of Elder; they also add, that there are certain little Spaces betwixt these Fibres, which serve as so many second Pipes. But if it were true, that the Fibres were full of Marrow, there would necessarily be in the Brain, a third distinct Substance, quite different from the White or Ash-colour'd Substance, but as there are no more than these two foresaid Substances, there is no reason to set up a Third.

As for the Nervous Fibres, they contain no Marrow at all in them, and nothing passeth thro' them but Spirits. They say also, for a further Proof, that these Nervous Fibres do contain Marrow in them; this, that they are soft and moist, and that if one squeezeth the Nerves together, there cometh out of them a Marrowy kind of Substance. But if the Nerves have any softness, and are always moist and flexible, all that ariseth from those Lymphatick Vessels, and other Vessels which carry Blood, which

water or bedew them; As to the Marrow which d
 path from 'em when they are pressed, that is not
 but the *Lympha* mixed with the Texture of the
 your Pipes which are bruised or squeez'd on that
 cation.

Blasius Here's an Opinion which is very opposite to
Anatomy of first about the structure of the *Medulla Spinalis*. T
 the *Me-* will not allow that the Nerves are made of the
dulla Spi- dulatory Substance, but that all their little Threads
nalis. the pure Productions of the *Pia Mater*; so that
 one cut one of the biggest Nerves of the *Med-*
Spinalis, one seeth nothing but an abundance of sm
 little Membranous Threads, and nothing of a M
 rowy Substance. We must observe here, that t
 mistake here the Coats of the nervous Fibres,
 the Fibres themselves; for all the Fibres of
 Nerves of the *Medulla Spinalis* receive their Co
 or Cases from the *Pia Mater*. They are mistak
 for want of observing well every thing that is w
 in their Cases; had they cut one of these gro
 Nerves cross-ways, they would have seen the M
 row come out in pressing it together, as it hath be
 said.

Moreover, it is true, that there are certain li
 spaces betwixt the nervous Fibres of the Nerv
 for let them be of what figure they will, or never
 small, they can never be so closely join'd togeth
 but that one may still imagine some small spaces
 twixt them; but yet these spaces betwixt them w
 not do the Office of Second Pipes, and the Spir
 will always run or flow thro' the Excretory Pip
 It is yet true, that the more subtle and refin'd Par
 cles of the Spirits, and the remainder of the *Lympha*
 may pass along these said spaces, as well as the Spir
 which penetrate thro' the Pores of the nervous F
 bres, and the *Lympha* which floweth thro' the Pores
 those Lymphatick Vessels which belong to the ne
 vous Fibres. But that which is gathered in the
 Vessels which are, as I may so say, insensible, is n
 derived from the Brain; for every thing that com
 eth thence is separated into the Glandules of th
 Cortical Substance, in order to flow into all the sma
 little Threads of the Medullary Substance, and from
 thence into the Nerves, since these small Thre
 are all of a Piece with them.

In fine, the being of a *Succus Nervosus* or juice of the Nerves, entirely distinct from the Spirits which flow into the Nerves, is what can never be supposed. They say, that the Animal Functions do weaken, or diminish the force of the Body by dissipating the Spirits, that in Sleep Animals do recover their strength, and thrive better, which can be no ways made out, without supposing two kinds of Nourishing Liquors, since by Sleep the Course of the Spirits is interrupted, and there is then no such thing as nourishment perform'd. 2d. Some Convulsive motions must needs happen in Sleep, were not the Course of the Spirits interrupted. 3d. They add, that if nothing but the Spirits flow into the Nerves, without any *Succus Nervosus*, and that this Course of them is continual, the Impression of the Objects will never be able to pass even to the Brain.

To Answer all these Arguments, we say, that if Animals thrive more in sleeping than in being awake, it is because there is not so great a dissipation of the Spirits in the Night, as in the day, and the Course of the Nourishing Juices is then more Calm, and Moderate; we see then that the Course of the Spirits is continued as well in our sleep, as when we are awake. Besides we must not imagine that the flowing of the Spirits can cause any Convulsions in our sleep, since it is certain that no Convulsive motions can be excited without some great impetuosity of the Spirits. In fine, we have shewn after what manner the Spirits communicate or carry the impression of the Objects to the Brain.

C H A P. VI.

Of the Outward Sences.

HAVING treated of the Animal Functions, and shewed after what manner they serve or contribute to motion or Sense, and how they preserve Life we must now pass on to the explication of the Outward Sences.

Animals have Sences bestowed on them for the preservation of their Bodies, but Man hath this Privilege above all other Brute Beasts, besides his Sences which qualify him to know and distinguish Outward things, he is endued also with reason; which after all, tho' it helps him out sometimes, doth oft deceive him more than if he had only his Sences rely on. For Example, it often happeneth out, that we judge certain Foods or Meats good or bad, without so much as having ever tasted them, and we pass this Judgment of them, either because we have seen them, or that we have received such a relation of them; so that it is purely our judgment which maketh us believe them to be good or bad. Thus, without any further choice, we take them in our Mouths, and Eat them, if we think them good, and on the contrary reject them, if we judge them naught or bad.

As Animals employ their Sences, purely for the Preservation of their Lives, they never eat any thing without first smelling to it. Dogs find out, and distinguish their own Masters by their smell. There are some Animals which have no Eyes at all, but to compensate that Defect, Nature hath furnished 'em with an extraordinary fine Touch, thus they easily distinguish all sensible Qualities. Touching is the necessary of all the Sences, 'tis this that distinguisheth Animals from all other insensible Things. When they say that an Animal is a Living Body, capable of Sense and Motion: The first Idea that is represented in our Mind, is this, that it hath the Organs

Touching, for there is no Animal without that, they may be depriv'd of other Senses; so also Animals want their Tasting Faculty, by this chuse what is necessary for their Nourishment. there are some which only make use of their smelling, for the choice of their Food, as we have serv'd.

There are some Animals, which in respect of such have the five Senses in Perfection, seem to enjoy nothing but the Sense of Touching. There are other Animals which seem to have more than five Senses, such as those which perceive certain Things, which the most perfect Animals do not perceive at

This difference is to be ascribed purely to the variety of Things which may be profitable or unprofitable to some certain Animals, for we must not believe; that what is useful to the greatest part of them in general, must needs also be useful to certain particular kinds of them. Such which naturally are immoveable, as Oysters seem to have no more Sense than the Rocks, to which they are sometimes fasten'd all their Life Time; For what advantage would there have been to them, to know all the good and ill things which other Animals know by their Senses? few are the Things which are proper, or not proper for them, that Nature who made them immoveable hath give them no Organs for seeking or avoiding them.

We shall not make any stop here, to shew that there are some Animals which have no smell at all, and that there are others whose Taste is very weak, since they indifferently feed on all kinds of Herbs, without making any choice. But on the other side, there are other Animals which seek out only such Herbs as seem agreeable to them. Some Animals have a more-imperfect Hearing; in fine, there are some Animals which seem to have more than five Senses; for Example, such as perceive the change or variation of Weather or Seasons, which foretell Storms and Earthquakes, must certainly have some particular Sense, to make them thus sensible of these Changes. We are not yet assur'd whether it is by smelling, that Flies, Ants, and many other Insects, know what is proper for their Nourishment. We

often see, that Ants come from the end of a Garret and climb up to the top of a House, to pass thro' Chinks of a Closet close shut, where there is any gar? It is hard to determine how they come to perceive a Thing that is at that distance, and so conceal'd from them, unless we suppose that the fineness and delicacy of their Touch, supplieth in them want of all other Senses.

Sensations in general, are the manners of knowing and perceiving outward Objects, in as much as they are sensible and corporeal; that is to say, according as they are extended, or form'd under such a Figure and are moveable, and have all other Qualities render them sensible: For the Soul may also have Knowledge of the Objects, without forming any corporeal Images of them, as when she knoweth them only by the Intellect or Understanding.

As there are two kinds of perceiving the Objects either when the Nerves are touch'd from without when the motion passeth even to the Brain, or even when the Spirits recollect themselves, and run over again their former Traces in the Brain; so for this very reason, the Senses have always been divided into inward and outward Senses.

School men pretend, that there is no need of any Action for the performing any of the outward Sensations, it being enough, that the Senses receive an Impression of the Objects, in order to be changed by it, and that this change or Alteration is perceived by the Soul in the Brain, where common Sense resides.

*Mr. de la
Chambre.*

Some have said, that even Animals have also the Perceptions, that is to say, that they think, and reason, as we do; but if we once confound those motions we observe in Animals with Sensations, we must then assert, that they have a Principle of Knowledge. On the other side, if we reason fairly, and without prejudice, we can draw no other Conclusion from the surprising Actions of Animals, but only that they perform them all by the pure disposition of their Bodies.

By sensible Qualities we must not understand anything that is really distinct from Matter, or its Modifications, but by this general term we must understand

the Mechanical dispositions of Matter; as for
 ple, Figure, Magnitude Situation, Motion,
 &c. It is by vertue of these Modifications that
 make any Impression on our Organs, and that
 make us perceive Colours, Smells and Tasts, &c.
 is nothing then in Bodies, which can occasion
 ions, but Figure, Situation and the motion of
 Particles.

The Organs of the Senses are not pure simple Con-
 thro' which the Impression of the Objects is to
 without receiving any change there; but these
 have a particular structure, fit to receive the
 of the Objects, and at the same time to mo-
 and qualify it, in order to be perceiv'd by
 soul. For Example, the Ear is not to be look'd
 as the Breech of a Trumpet for the receiving
 the Air; there are at the bottom of the Conduit, a
 with a Skin, and little Bones, &c. a *Laby-*
 to give the Air, which the Ear hath receiv'd
 without, a new Modification for the making
 sound.

Also the Eye would not be able to see, tho' the
 were open enough to let in the Rays of
 even to the *Retina*, were there no Humours
 modify and break the Light, to the end, that
 the Beams which come from one Point of the
 may be united again into one Point in the

It is with the other Organs, they have a parti-
 structure for the modifying the motion of the
 so that if there is any change or alteration
 structure, there presently followeth a change
 perception; and when that is once destroyed,
 is no more Sensation.

We have knowledge of no more then five Sen-
 Animals, so we commonly allow them no more,
 we know all the Species of Animals in the
 so far as to know, that they have but five
 May there not be several Birds, and other
 in *America*, which may have certain particu-
 quite distinct from those we are acquaint-
 for the perceiving changes of Air, fortel-
 of Tempests, fruitful or unfruitful Years. The
 have observ'd, that Ants make greater Ma-
 gazines,

gazines, when any scarcity of Grain is like to be. If this is true, these little Insects must needs have some particular Organs, to make them sensible of the change of Seasons.

CHAP. V.

Of Touching.

OF all the Organs, of the Senses, that of Touching, hath been always said to be the most imperfect, because in that Point, there is a necessity that the Objects be near, and even touch the Skin. It is also the reason say they, why the Objects of Touching are gross and solid. It is true, that Touching when we reflect on it in general, will seem imperfect, but when we consider it more particularly, we shall see that it is the most universal of the Senses, and that all the other Senses receive Impressions purely by way of Touching.

Being then to treat of the Organs of the Sense, it is very reasonable that we begin with Touching, since there are no Animals without it; for even the vilest, and which the Ancients considered as Insects, are yet endued with a very fine and delicate Touch. There is no touching in a Snail, but he presently draws back himself, as the Cuttle-fish, Muscles, and all other Shell-fish do; so that we may well maintain, that the Sense of Touching in these Creatures is in a greater degree of perfection, than it is in those Animals which are considered as imperfect. This quick Sense of perceiving, of things, was absolutely necessary for the preservation of their Lives; and as the structure of their Senses is extraordinary fine, Nature hath also furnished them with Shells which are very hard, into which they retire, as soon as ever they perceive anything that commodates them.

Touch of other Organs, as the Eye, the Ear, the Tongue, &c. is bounded and limited, as I may so say; on the other side, that of Touch is universal, for by it, it is that we are made acquainted with all things which surround us.

The Objects of Touching, are not only Heat, Cold, Dryness, Moisture, but even the Solidity of Bodies, and also their Fluidity, as well as their Roughness and Smoothness, we see then, that the Touch of the Skin is much more universal than that of any other of the Organs of the Senses. Man hath the finest Touch of all other Animals, for tho' there be some Animals which excel him, as to the Senses, yet none of them can be said to surpass him in Touching. It is commonly said, that the Spider hath incomparably a much finer Touch than any other Animals, which is not true, since the Touch of Bees and Ants is extremely delicate: The Opinion of the Spiders having so fine a Touch, was occasioned from this, that a Fly can scarce touch his Leg, but the Spider immediately runneth to seize it. But how can this any ways heighten our Admiration! It is not the Fly that toucheth the Spider, but the Fly being once catch'd in that fine Net, endeavouring to get out shaketh it, is it then so strange that the Spider should perceive it? Since the Spider is extended over the little Hole, in which he hideth himself. This Instance doth not any ways prove, that the Spider hath any finer Touch than any other Animals.

To the Spiders Web, we shall observe by the by, those small white and fine Threads which we see swimming up and down in the Air, and are commonly call'd, *The Virgin Thread*, they are the Work of young Spiders. These little Threads usually appear in the Spring, and during the Autumn; they are often seen on Bushes, on the Stubble, and on the Grass; and as they are toss'd here and there in the Air by the Wind, they often stick to one's Hat. Some are of Opinion, that this *Maiden Thread* is only a kind of dried Dew, and a Famous Philosopher, *Mr. De Haemel*, a Writer, saith that these small Threads are nothing but the Exhalations of our Climate. But yet it is certain that this *Maiden Thread* is the Work of Spiders,

Spiders, as we have said before. I have seen work, and they are even to be seen sometimes Thread which the Wind carrieth away. When Spiders are disposed to spin, they commonly from one side to the other to stop their Thread afterwards they presently mount again, drawing Thread after them. This is common to all Spiders, but that which is more surprising, and to be observ'd, is to see that this small Thread cometh from the Belly of this Insect with the same and Impetuosity, as a Spout or Water-work doth. This little Thread comes out thence and Starts, at that time the Spider turns his Tail to the great Wind: This small Thread which is carried by the Wind, and still continueth to come out of the Belly of the Spider, is presently extended for many Fells. The Spider at first draweth her small Thread downwards, balancing her self in the Air. In Spring and Autumn one may see both young and old Spiders making their Webs on the Trees and Bushes, running on their small Threads to catch the Flies which are entangl'd in them. These small Caddis-flies fall on, and devour each other, but the Spider is in a manner always victorious, because of the Force it hath to go and run on his Webb, whereas the Flies cannot support themselves there. Sometimes there are no Spiders found in the small Threads which the Wind carrieth off, and which fall to the Ground, sometimes also there are four or five.

At some certain Times or Seasons, the Spiders work after another manner; for instead of running on their small Threads which the Wind carries off, they draw them to them, to make a little Ball, in which they put upon their Heads; sometimes they break the Thread, and let it loose to the Wind of the Air or Wind. This Sport they often repeat from time to time, keeping before them the Skeins of these Bottoms, still driving out of their Mouths fresh small Threads, with which they balance themselves and play. We must observe that these small Threads interwoven with each other are much finer than those which are spun commonly in Houses, for those are the Work of old Spiders.

ing already mentioned the sensible Qualities of
 thing, it is useless to explain in what the rough-
 smoothness of any thing consists, this is a
 evident of it self. Yet that which hath seem'd
 to the Touch, hath afterward appeared
 and irregular to the Eye, by means of the Mi-
 spe: For Example, thus the finest Edge of a
 Razor, the Point of a Needle, Stuffs, as Sar-
 these Things seem rough. The Edge of a
 looketh like a Saw, with great Teeth, the
 of a Needle seems all blunt.

Moisture and driness do not any ways differ
 Solidity and Fluidity, we shall not make two
 Qualities of them, &c.

Humidity say the *Aristotelians*, is that which is dis-
 contain'd within its own bounds and driness;
 other side is what is easily contain'd within
 bounds: Now according to the Opinion of the
 it appeareth that Humidity differeth not
 from Liquidity, and that Driness dependeth
 on dryness. For Moist and Dry are Relative Qua-
 A moist Body is that which wetteth ano-
 and a dry Body is that which wetteth

one asketh here, what it is to wet, we an-
 That Wetting is the entring of a fluid Body in-
 Pores of a hard Body, so far as to soften all the
 of it; therefore Water is a fluid Body, and
 same time a moist Body in respect of the
 which it wetteth. But *Quick-Silver* and Air
 is dry, tho' they are fluid Bodies, are not
 humid, because they wet not. Yet *Quick-*
 may be look'd on as a moist Body, in respect
 of Lead, because when it is mix'd with these
 it penetrates them, and maketh an *Amalga-*
 that one may say that *Quick Silver* is a Liquid
 wetteth not the Hands, but yet moisteneth
 The Water which is Humid, in respect
 of Lining, or Stuffs, &c. yet in respect of
 Grease, it is not Humid, since it penetrates
 their Pores, nor can fasten it self to their Su-
 So also Oyl, which is a Humid Body, in
 of Things which are dry, yet is not so, when
 things are once wet with Water. Those soft
 Bodies

Bodies which hold a Medium betwixt Solids and Fluids, are included within the Sphere of Touching. As to Heaviness and Lightness, these Qualities do not properly belong to the Organ of Touching.

The Ancients are much puzzl'd to know what that chief Part, that is capable of perceiving Things. Some of them think it is the Flesh, that it is the Skin. Others again will have it to be the Membranes, the Muscles and the *Parenchyma*. **Casseri** is capable of Touching. An able Anatomist is of Opinion, That the Flesh and the *Panniculus carnosus* is the Organ of Touching; He saith, that the Part is no ways sensible without the Membranes, that they want a middle Temperature to make the Touch.

Yet all this while the Membranes are not the Organs of Touching, it is true, that they are very sensible, when they are either prick'd or torn; but they do not make us sensible of the Qualities of other Things, as smoothness, roughness, hardness, softness, and other Qualities, which we perceive by the Skin. For Example, in any Part of the Body where the Skin is lost, and that there is a Skin, the Faculty of Touching is much diminish'd. When we say That the Skin is the Organ of Touching, we do not mean the whole Skin, for there is one Part in this Cover, which is capable of Touching. It is neither the Membranous nor the Nervous Substance, which is the immediate Organ of Touching, but it is those Nervous Tufts, *Malpighi* first discover'd to us.

If you have a curiosity to view the structure of the Skin, you must first take off the *Epidermis* by pulling it with a hot Iron, or any other way. When once remov'd, one may perceive another Part, the *Epidermis*, of a Convex figure, much resembling a Cupping-Glass. When this little small Part is stretch'd out, it stoppeth up the Excretory Conduits of the Sweat, and when that it is relax'd again, or relax'd, the Sweat floweth: This was the Opinion of him, to whom we are particularly oblig'd for those great discoveries he hath made in the true structure of the Skin. We have re-

other place, whatever there was most probable
 the use of these Valves; we have asserted, that
 did not serve so much to moderate the flowing
 of the Sweat, as to support the effort of the Air,
 by virtue of its Spring, much presseth toge-
 ther the Skin; for in the manner in which they
 are directed to the Orifice of these Excretory Pipes, we
 see how they should be able to oppose the
 force of the Sweat. In Effect, let them be never
 closed, since they look inwards, and have the same
 position as the Valves of the Lymphatick Vessels,
 can never retain the Sweat, or hinder it from
 passing.
 I think methinks no one as yet hath explain'd what
 makes these Valves stiff or loose. It is
 Mr. Malpighi barely saith, that they grow stiff,
 when loose again, but he layeth down no reason
 for it. If there is nothing to bend, or to render
 them loose, what shall hinder the Sweat from keep-
 ing them always open by their Motion? They may
 shut off themselves, which will hinder Trans-
 mission, by creating some obstruction in the Glan-
 der of the Skin. We see then, that these Valves
 are not that use which is ascrib'd to them, but that
 they only serve, as it hath been said, to support the
 effort of the Air, and to prevent its opposing the
 expiration.

There is also under the *Epidermis* or *Cuticula*, the
Retiçulare, thro' which the Nipples of the
 nervous Tufts pass. This Body is, in a manner, as thick as
 the *Membrana Reticularis* of the Tongue. The
 nervous Tufts pass thro' the Net-Mesh, they are all
 in a parallel Line, or order: The Excretory Pipes
 are betwixt these Parallels. All these Nipples are
 directed in the *Cuticula*, which they bear up by
 giving it a little bending outwards. They are com-
 posed of many small nervous Fibres, which one
 may easily discern under the sole of the Foot
 of a Turkey-Cock, when the *Cuticula* is taken
 off.
 Since these delicate parts are more plainly seen or
 covered in great Animals, one may take a piece
 of the Skin of an Ox, newly flay'd. The *Cuticula*
 or upper Skin being taken off, the nervous Tufts
 appear

appear very large; this is also easily observ'd Sole of a Hog's Foot, when the horny part is off, which is instead of the first *Cuticula* in all mals which are cloven footed: For under the of a Hog's Foot, there is another *Epidermis* which is thick and black. The nervous Tufts are Conical-Figure, like those on the Tongue and Lips.

In Man, and in other Animals, there is under *Epidermis* a certain Glue call'd *Corpus Mucosum*. Varnish in Animals is not of the same colour the Skin, in some places it is black as, *China Vasa* in others again it is white and yellowish. The different colour of this Glue may be of great use in explaining the reason why the Skin of *Aethiops* is black, for it is also true, that some of them have white Skin, as well as a white *Epidermis* or *cutis* Skin; so that if their Skin is black, this proceeds from the Varnish which is spread all o're the *Membrana Reticularis*, or which is immediately under *Epidermis*, which is Transparent. From hence may be derived the cause of the different colours of Skin in most Men; For since this Net hath not always the same Varnish on it, it being sometimes Black, Olive-colour or yellow, the Skin also needs be dyed with the same colour. But when the Varnish is white, and that the *Epidermis* is fine, that one is in the flower of ones Youth, or there always appeareth in the Face an agreeable mixture of Lillies and Roses, and all the Skin is white.

This Net, and the Varnish, (a *Corpus Mucosum*) serve only for the preservation of the Nipples, to prevent their growing dry. There are an abundance of these nervous Tufts in those places where the Skin is very sensible, as in the Fingers: They are derived from the *Corpus Nervosum*, which is not else but a Texture of cutaneous Nerves, as it appeareth in Parchment.

If one hath the Curiosity to view, with the Microscope, a piece of the Skin of a Man's Arm, one may discover there several small Nipples, which are raised above the Net, as also, in other places of the Skin. The Basis of the Nipple of the Skin is nothing

expansion of the Nerves, which piece it in different places.

we reflect on Nature in the structure of the Senses, especially in that of Tasting, shall soon be convinc'd that these small Teats nothing but the lengthening out of the Nerves, which sometimes form a fine delicate Web, such as the *Uterina* is; or else they compose certain small Nipples by spreading themselves on the Skin, for if there were any numbness in any part, upon the Nerves being squeez'd or press'd together, or that the feeling together lost upon any considerable Obstructions; is certainly an Evident Proof, that all this proceeds from the Nerves. For Example, it is related of a certain Woman having receiv'd a blow on her Forehead, which, thro' the violence of it, took away the use of her Fingers; a certain Chyrurgion cured her not by applying any Plaister to her Hand, as another Skillful might have done; but by applying a plaster to her Neck, because of the Origin of those Nerves which go to the Arm. A Modern Philosopher relating the History of a certain Woman, who had much pain in a Leg which was cut off without being sensible of it, saith, that this pain, which she perceived from time to time, did any proceed from the Irritation of some sharp humour which had reach'd the Nerves after the same manner, as when it reach'd to the extremity of the Foot. But we will deliver another Account of this Phenomenon, at the end of this Chapter.

Mr. Malpighi in his Letter to the Baron de Frankville.

Gassendus

Malpighi assureth us, that he is often troubled with numbness in the Palm of his Hand, and in his Finger, after he hath lean'd, for some time, on his Elbow, in Bed, or upon a Table, and that this numbness lasteth for some time: Thus he explains this Phenomenon, he saith, this happeneth not thro' any compression of the Skin, for then that numbness should be above the Elbow; but that it is rather thro' a compression of the Nerve, which Agitates and puts those places in motion, where the Nipples of the Nerve are form'd.

The Antient and Modern Anatomists having observed an abundance of Nerves in the Skin, have call'd it the Name of *Nervus Sanguineus*: Others

again

again have thought that the Skin was only an Extension of the Nerves. But Experience sheweth that the Skin is a Texture of Nervous Fibres, of particular Disposition; they are easily discovered as a piece of Leather that hath been us'd, or in a piece of Parchment. Some of them are extended straight ways, others obliquely; they are placed under the outward part of the Skin, which makes it seem to be a kind of quilting. In this place the Skin is smooth and polish'd. These Fibres being interlac'd or woven one with each other, do form a kind of a Net, much resembling that on a Fig-le.

Mr. *Malpighi* maintaineth, that the Origin of the Nervous Fibres of the Skin, is not as yet discovered, and that it must cost us many Dissections to come to this Point. The Industrious *Vesalius*, saith he, in his Observations sheweth, that the Nerves of the Skin of the Face, the Arm, the Elbow, and the Hand have each of them their distinct Organs, and that the Nerves of the Mouth and Face are derived from the *Tertium*. Another Anatomist observeth, that the Nerves of the 3d. 4th. or 6th Pair, are extended all the Skin. *Willis* saith, the Skin receiveth Nerves from the 5th 6th and 7th Pair, one may also say from the 8th. *Glovius* in his Anatomical Table sheweth several Nerves which go to the Skin, which take their rise from the *Medulla Spinalis*.

But since all these able Anatomists, some of whom have been very busy, in particularly discovering whence these Nerves are deriv'd, which are probably lost in several places of the Skin. It is known, for Example, that the Nerves which go to the Skin of the Face, and to the top of the Head, proceed from the *Portio Dura* which cometh out of a hole betwixt the *Aophysis Mastoides* and *Stylus*, and that it also receiveth some Branches from the 1st Pair, one whereof is called the *Ophthalmick Branch*, which passing thro' the superciliary Hole of the Orbit of the Eye, turneth to flesh in the Skin of the Forehead. It is known also, that the Skin of the hinder part of the Head, receiveth Nerves from the two first *Vertebrae*, and that all the Neck receiveth some from the 3d and 4th *Vertebrae*, and from the first *Dorsale*. The Back and the Breast receive some from the 1st

Vesalingius.

1: The Loyns have some from the two *Paria*
umbaria, and from the *Os Sacrum*, and the fore parts
 the Leg and Foot, from the formost Branch, and
 the Exteriour Parts of the *Sciatica*. In fine, no one
 more nicely observ'd the Nerves of the Skin,
 than Mr. *Vicussens* in his *Neurologie* or discourse of the
 Nerves; this is a piece which we cannot consult
 too often, when we are disposed to understand the
 Nerves.

One may here object a difficulty, how is it possi-
 ble that all the Nervous Fibres of the Skin should be
 deriv'd from the Brain, since all the Nipples and
 Nervous Tufts of the Skin put altogether, must
 form a much bigger Bulk than that of the
 Brain, and the *Medulla Spinalis*: But to this we an-
 swer, That the same thing must be urged as to
 Plants and Trees, in which, the vast number of Fi-
 bers, which compose the Branches, the Leaves, the
 Flowers, and the Fruits, is of the same Substance
 with that of the Trunck, since all those Fibres are
 lengthen'd out of it.

If we would know after what manner the Ob-
 jects touch the Skin, we must remember what hath
 been said about Sensations; we have shew'd, that in
 every moment that the extremity of a Nerve is
 touch'd, an Undulation or Shivering must needs
 follow, which passeth even to the Brain, because the
 Pipe or Conduit is full of Liquor from one end to
 the other. So one also cannot touch the Nipples
 of the Skin, but that the Spirits will make these Un-
 dulations, which will be different, according as the
 Impression of the Objects is more or less strong; and
 as the Tension of the Nervous Fibres is too great, so
 the Spring of the Fibres giveth too great an agi-
 tation to the Spirits, one feeleth pain presently, be-
 cause the Tumultuous Agitation of the Spirits doub-
 leth the Shivering of the Fibres. The shaking then
 of the Nipples of the Skin is different, accord-
 ing as the Particles of those Objects which touch
 are different in their Figure, Bigness or Motion,
 those Bodies which touch us, do not immediately
 touch the Nipples of the Skin, because of the *Epider-*
mis or *Cuticula*; but all these little Tufts bend a little
 towards toward the Object, in order to receive
 their

their Impression, for Animals are surrounded with an Infinity of different Objects, which are continually acting on their Organs, this made *Plato* say, that the motions of the Objects which are about us, pass from the Senses to the Soul, to make a quick strong Sensation, there is no necessity that the motion which causeth it to be very great or strong, a slight shaking, tho' at a distance, is often sufficient to cause a brisk Sensation. This we learn, by Experience, from certain *Machines*, in which a small force is sufficient to stir a great Burden. Thus we are not to be surpriz'd, that a slight motion should be able to excite a strong Sensation in Animals, who are *Machines* that incomparably transcend all Artificial ones.

All that we have even now mention'd about the Organ of Touching, perhaps, will appear not so clear, saith *Malpighi*, should we relate here the opinion of *Aristotle*. which is a pure Riddle to me. This Philosopher saith, that Touching is an Instrument hid within the Body, which is the same in *potentia*, as it is in *Actu*, when the Objects Touch. Tho' all the Commentators, as well *Arabian* as *Latin* have thought that *Aristotle*, in this place, spoke of the Nerve; yet since the Nerves are situated under the Skin, it is evident they cannot be touch'd by anything that is rough or smooth, which only immediately affect the Nervous Tufts of the Skin.

Here's a question which hath been much debated in the Schools, that is, whether Touching requires any *Medium*? For it is an Axiom, that the thing applied on the Senses, makes no Sensation at all; and some have maintain'd that Touching cannot be effected without a *Medium*, and others have said, that the *Medium* would hinder the Production of Intentional Species. There is no reconciling of these two Opinions. First the Nervous Tufts are terminated on the superficies of the Skin, so that they seem to be no more like Nerves, but to resemble something that cometh near them, and which serveth as a *Medium* to moderate the Impression of the Objects.

The *Epidermis* or Upper Skin is of great use to prevent the Touch's being painful; for if on any occasion the Nervous Tufts happen to be de-

of it, Sensation, then groweth very Sensi-
 There are abundance of small Glandules under
Membrana Reticularis of the Skin: These Gland-
 es have certain Sanguineous Vessels, with a small
 ve that runneth a cross them, which is divided al-
 into certain imperceptible Branches. The Ex-
 cretory Pipe openeth Outwardly, as we have obser-
 ved before in speaking of Transpiration.
 The Orifice of these Excretory Pipes is large in
 the Glandules of the *Membrana Pituitaria* of the
 nostrils of an Ox, or a Calf, in squeezing them there
 cometh out a certain thick Liquor, which is nothing
 but Snout. All the *Cutaneous* Glandules are the Foun-
 tains of Sweat, and the insensible *Emunctories* also,
 amongst which one may reckon the Lungs, because
 they serve for the separation of those *Heterogeneous*
 particles, which could not mix with the Blood. The Hippocr.
 6 *Epidem.*
 Patients have observ'd, that they which have a soft
 and delicate Skin, have commonly a hard Belly, or
 are Costive, because there being a considerable Eva-
 poration in one place, it must needs be less in
 another. In fine, one may add, that Transpira-
 tion is also necessary to hinder the Nipples of the
 Breast from being dried up, and from becoming
 callous by the continual rubbing of Outward
 Bodies on it; perhaps this is the reason why one
 sweateth more in the Sole of the Foot, or in the
 Palm of the Hand, as also under the Arm-pits, and
 in the Breast, because these parts are very sensible,
 and are always in motion.
 In order to finish this Chapter, it will be very pro-
 per here to explain a certain *Phenomenon* which de-
 pends on Touching. We know, by Experience,
 that all those who have had an Arm, or a Leg cut
 off, do feel great Pains a long time after; and they
 often imagin, that they have their Limbs still; tho'
 they have lost them for several Years; and those of
 strong Imagination will tell you, that it seemeth to
 them, as if they had the use of their Fingers and
 Legs as before, according to the Sentiment of these
 famous Philosophers. This *Phenomenon* hath been Gassadu,
 always explain'd, by saying, that the pain which one Descerto.
 feelth upon the amputation of a Limb, pro-
 ceedeth

ceedeth wholly from the sharpness of the Humours which affect the Nerves, just as it did when the part was whole and indisposed. We would willingly leave this extraordinary difficult Problem to be solved by others that are more able; but in matters which seem obscure and difficult, we must make some generous Efforts to conquer that difficulty. We have already often said, that the Objects which touch the Organs of the Senses, do cause a certain reflux of the Spirits even to the Brain, in order to make a Sensation there. But yet the Objects are not always the cause of this Reflux of the Spirits, for it is often produced by the Spring of the Nervous Fibres; thus in cutting one part of the Body, there must needs follow a considerable Tension in the Nerves, and the Spirits, at the same time return to the Brain with a kind of impetuosity.

This motion of the Spirits is certainly much greater, since after that the part is cut off, the Nerve which remaineth, and which is extended even to the head, is shorter, therefore the Spirits which flow from the Brain into this Nerve, are so crowded together there, that not being able to go any farther, they are reflected against the Bank, and those which flow at every moment from the Brain, are violently beaten back again, not only by reason of this reflux but also from the Trembling which the Nervous Fibres have received in the Operation; this perhaps is the cause of those Pains which continue afterwards.

In fine, Experience also sheweth us, that those Invalids, who have lost either an Arm or a Leg, are commonly subject to the *Hemorrhoids*. Bleeding at the Nose, &c. which is not to be ascribed to the Fermentation of the Blood, but rather to the great quantity of it: For, without doubt, after the loss of any Limb of the Body, there remaineth in the Body more Blood than is necessary, since the Blood which was to nourish the Member which hath been cut off is now useless: Therefore it must needs have a Vent or Evacuation in some part or other of the Body. This *Phenomenon* confirmeth, what we have said about the Cause of the Purgations of Women: For this their *Periodick* Flux must needs proceed pure

from the superfluity of Blood which Women
 since they have more than is necessary for
 their own Nourishment, as we have supposed.

CHAP. VI.

Of the Taste.

Rutes make more use of their Nose than their
 Tongue, to judge of the Goodness of their Food,
 whereas Man judgeth of it by his Taste, because
 (they) he hath a finer Taste than any other
 Creature. All Senses are in a manner but so many
 kinds of Touching, but particularly that of Tasting,
 which hath so great an affinity with Touching, that
 several Authors have treated of them in the same
 Chapter.

In effect, if in Touching the Object must needs
 affect immediately the Organ, so also in Tasting
 the Savoury Particles of the Food, must immedi-
 ately Touch the Tongue; which is yet done alto-
 gether after another manner, than it is in Touching,
 where the Savoury Particles do not only Touch
 the Nipples of the Tongue, as other things do,
 but also shake the Organ of Touching; but they
 enter also very far into the great Pores of the
 Tongue, for the Agitating of the Nervous Fi-
 bers.

There is a great Affinity betwixt smelling and ta-
 sting, we taste nothing without smelling to it. If the
 smell which ariseth from the Food is agreeable, we
 judge it good and profitable, but if it be otherwise,
 we think the Food is not wholesome: Therefore one
 may very well say, that smelling is given us, in fa-
 vour of our Touching. Yet we cannot absolutely
 determine this Point, whether Man hath a finer
 Taste than any other Creature, or whether the Ape,

according to the Ancient Distick, excelleth us
no.

*Nos Aper Auditu, Lynx visu, Simia Gustu,
Vultur Odoratu, præcedit Aranea Tactu.*

For tho' one may assert, that Man excelleth all animals in Touching, and that he also hath a fine Taste, yet we must observe by the way that the variety of Food was no ways necessary for the Perfection of our Taste. We have then more reason to believe, that Man hath not this Organ so perfect as those Animals which are more temperate, for great a variety of Food, in the end must necessarily deprave the Excellence of the Taste.

Now Tasting is altogether necessary, not only for the Pleasure one receiveth in eating, but also to choose that which is proper for Nourishment. He who hath once lost his Taste, may indifferently eat anything that cometh in the way, and swallow Poisons instead of Food; to prevent this terrible Mistake Nature hath given Animals the sense of Tasting, that they may chuse out what is proper for their Nourishment, and avoid what is hurtful to them.

The notion of the savours or smells being certain real Qualities distinct from their respective mix'd Bodies, hath been a long time exploded, since it is well known that savours are nothing else, but several modifications of the Particles of savoury Bodies, which purely consist in their Figure, Motion, their particular Situation and bigness, &c. from all these Differences, the variety of Tastes proceedeth.

We have two Ideas of the Word savour, the first relateth to that which is in the Objects (*i. e.*) to the modification of the Particles of the mix'd Bodies, the second includes or comprehends the sense of Tasting. What is taken in the first sense, one may easily make others comprehend, because every one hath a clear and distinct Idea of Figure and Motion, but it is impossible to communicate to others, that Idea of Taste or Savour, taking it for the sense which exciteth in us, without a particular Experience of it in themselves.

Men have not the same Taste, even of the Meat or Food, that which is bitter to one, is sweet to another, and this Niceness ariseth purely from the Organ, which is not alike dispos'd in all; for the Nipples of the Tongue may be either bigger or less, and of a more or less delicate Texture, which will render them more or less capable of being affected or dispos'd, one way or the other. It is hard to determine in particular, in what the Nature of Tastes or Savours doth consist; we cannot (with the Ancients) that they proceed only from the mixture of the Elements, and their Elemental Qualities; for as the Elements have no Savour or Taste in themselves (according to these Philosophers) how can they communicate to it any mix'd Body? It is contrary to their own Axiom, that nothing can give to another, what it hath not in it

The Chymists derive these Savours from the diversity of Salts, of which mix'd Bodies are compos'd. *Mr Magnan* was so taken with this Opinion, that he confidently maintaineth, that Savour or Taste, is nothing else but the Action of Salt. It is probable enough, that it is the Salt which maketh the Body savoury, since such Bodies which have no more Salt in them, become insipid, as Ashes and Chalk. It is known also, that when any thing hath lost its Taste or Savour, it is an easy thing to restore it, by adding some Salt with it; this good Cooks perform every day.

Tho' it be true, that Salt causeth Savour or Taste, we must not therefore imagine with the Chymists, that they are such Salts as they are acquainted with. There are several mix'd Bodies, all full of Salts, which yet have no Taste or Savour at all, as Bones, &c. which yet afford a good store of Salt by Distillation. 2d. Tho' all Salts have a very penetrating Taste, and that being mix'd with each other, they may produce certain Tastes, altogether different from those they had unmix'd, as a salt Body, made by the mixture of an Acid, and an Alkali: Yet since the Chymists scarce allow any other Salt than Acids and Alkali's, their mixture will not be sufficient to produce the different Savours or Tastes, which are in a man.

manner infinite. 3d. The mixture of an Acid with an Alkali; doth not always produce a Salt according to the Opinion of the Chymists, if mix the *Spirit of Nitre*, which is a very powerful rofive with any Alkali, as *Pot Ashes*, you will have true *Nitre*, which will not be corrosive at all, but will have something of bitterness in it; and we even make a very sweet Salt, by mixing of an Acid with an Alkali. We have an Instance of it in the solution of *Saccharum Saturni*, when it is precipitated with the *Spirit of Sal Armoniack*, nothing is sweeter than this mixture. All these Instances then shew that all Savours or Tastes proceed from the Saline Particles, but not only from the Salt; the Salt must receive certain Modifications with other Principles by which the Particles of it may be so rang'd or dispos'd, as thro' their bigness, Figure and Motion together, they will become proper to make or form different Tastes or Savours.

There have been several Experiments made which shew, that the different mixture of saline Particles not only with sapid or savoury Bodies, but also with those which are altogether insipid, produce very different Tastes. If one dissolveth silver in Aqua Fortis, and precipitate it by mixing it with Brine, we have a *Precipitatum Lunæ*, which will be very bitter, which will also lose its bitterness, when it is melted over the Fire. *Saccharum Saturni* becometh altogether insipid, when it is precipitated with the *Spirit of Sal Armoniack*, *Bismuth* and *Tin* grow insipid when they have been once dissolv'd by an Acid. These Dissolutions have different Tastes, according to the Nature of the Dissolvent. Those Earthy Particles or Substances which are purely insipid, do not acquire a certain Taste (which is sour enough) unless they are mix'd with Acids; on the other side, if you mix but an Acid, on red Lead, or Ceruse, you will have a mixture which will be as sweet as Sugar. In fact, if we dissolve *Silver* in *Aqua Fortis*, the Liquor becomes as bitter as *Bile*, but we may recover its Acidity by distillation, and then the Metallick Part will remain insipid, because the *Salts* will then be no longer united with the Metal.

the different Situation or ordering of the saline
 in mix'd Bodies, is capable of producing
 all kinds of Savours, as we have now observ'd,
 of the same Particles, doth also con-
 tribute much to it, because it rendereth the Bodies
 savoury. For Example, all *Aromatick* Bodies
 make a strong Impression on the Tongue, because
 their Particles are in motion: Thence it is that
 Meats are more agreeable to our Palate, than
 which are cold; for the Heat by putting the
 in motion, disposeth them the better, to affect,
 like the Nipples of the Tongue.

Corruptions and Fermentations we are also to
 note, that the Savours or Tasts are also different,
 these motions by a frequent Agitation of the
 Particles, do sharpen them, being rubb'd one
 the other, so that they thereby grow more
 keen, and more keen than they were before; nay
 of them, as the lesser, become supple, and plia-
 ble. Millation also may produce such Tasts as were
 receiv'd before, because the Fire breaks the Par-
 ticles of the mix'd Bodies in pieces, those whose An-
 gles were too big or blunt, to penetrate into
 the Pores of the Tongue, are afterward so sharp and
 that there is no enduring them on the Tongue,
 an evident danger, as we see in the *Spirit* of
 when the *Salts* of it are extraordinarily subti-
 By that we see then, that if there are some Bo-
 dies which have no great Savour or Tast in them,
 proceeds not so much from the want of Figure
 of Particles, as the want of edge or sharpness in
 the Particles, which is necessary for their penetra-
 tion into the Pores of the Tongue. Meats when they are
 roasted, must needs have another Tast, than
 they were raw, because Heat doth in some de-
 gree, or change the Figure, and bulk of their

Particles of a Body are so subtle, as to affect
 us by Touching but very little or not at all,
 they will seem very insipid, thus, by Experi-
 ence we find that Water hath but a very little Tast,
 or none at all. Fat Liquors are not so sensible
 to Tast, as those which are not so, because the sa-
 line Particles are embarrass'd, and as it were hamper'd
 in

in the branchy Particles of the *Oyl*, and as the
or Spittle doth not easily incorporate it self with
it cannot penetrate it so far, as to make it shake
Nerves of the Tongue.

In fine, when a Body is so hard, that nothing
eth from it, as Mettals, Glafs and Flints, they
be altogether insipid: For those *Sales* which enter
to the composition of Glafs, had a Taste before
were congealed, and we have said before that the
solution of Mettals by Acids giveth them an insur-
mountable sharpness.

The *Saliva* or Spittle must be of it self insipi-
d before it can contribute any Thing to make us sense
of Tastes, as they are in themselves, for if it be
so little alter'd or chang'd, as it often happens in
Diseases, and that it cometh to be mix'd with
Foreign Humour, as the *Bile*, all things then
become bitter.

Having now spoken of the nature of Savour
Taste, it is now time, that we examine the principal
or chief Organ of Tasting. The structure of the
Tongue hath a great Affinity with the Organ of
Touching: First, The Tongue is cover'd over with
an outward Membrane which is pretty strong in
Brutes; it serves instead of an *Epidermis*. In the
Tongue of an Ox there appear certain small
knobs in the superficies of this Membrane, which are
bent or crook'd, and extended from the point of the
Tongue to the *Basiss*, which very well resemble
Card or Kemb to card Wool with. In Lions,
and Tygers, the Points or Tips of their Tongues
are hard, and as big as the Nails on Cat's Feet or
Claws. These Knobs are cover'd over with the outward
Membrane of the Tongue, as it appeareth, when
this Coat is taken off, for the impression of it re-
maineth on this Skin. The second Coat or Membrane
is Reticular or Net wise, like that of the Skin of the
the Net Mash of this, pass all those little Horns or
nervous Nipples. A certain white Glue or Viscum
is spread all over this Membrane, on the side called
Cuticula, which in the Ox is black underneath.
The *Corpus Papillare*, which is the third Membrane
of the Tongue, is yellowish in some places, and
in others; within side it is smooth, except where

men'd to the Tongue by these nervous *Fibres* which spread betwixt the fleshy *Fibres* of the Tongue. The *Corpus Papillare* is rough on the Out-side, by reason of all those small little Heads, which are formed by the Expansion of the Nerves, which have the resemblance of Mushrooms, since they have a very long Stalk with a small little Head on the top of it. All this put together doth much resemble the Bucklers of the Ancients.

In the Ox, the Goat, the Sheep and in Man, one may observe three kinds of Nipples from their Figure and bigness. The greatest are placed on the Point of the Tongue, and on the Tongue there are some which are four square, there are but few in the middle of it. On the sides of the *Basis* of the Tongue, these Tufts are not very numerous, on the other side they are very big. These Nipples having pass'd thro' the Net. are terminated under the outward Coat, and there where these little Nipples are incas'd or sheath'd, the Superficies which covereth them, is finer than it is in other places. There are also other lesser Nipples of a Conical Figure, which are terminated on the Superficies of the Tongue, as the others are: In fine, the Palate of the Mouth, and the Lips are also cover'd o'er with a thin Membrane, which hath Nipples much like those of the Tongue, with two Coats upon them. There are several small Glandules under these Nipples, whereof each of them hath its Excretory Pipe, which openeth outwardly, thro' which the Spittle is secreted. The nervous Tufts of the Tongue receive their Branches from the fifth and ninth

Pair of Nerves. The Substance of the Tongue is all Fibrous, under the nervous Texture, so that all these *Fibres* do constitute a Muscle of an admirable motion, and we may say that this motion is very proper to put also in motion those nervous Nipples in motion. For being join'd together by the several motions of the Tongue, they more easily receive the Savours or Sours. The first *Fibres* of this Muscle reach from the Point or Tip, when they are contracted, they draw the Tongue within the Mouth. There are also in the middle of the Tongue certain strait, oblique

lique and cross-wise *Fibres*, which being wove with another, do form a certain Texture like a Net. This Texture is so delicate, so soft, and flexible, that one is apt to believe that this *Mucous* Substance is quite different from others that which maketh it so soft, so delicate and so supple, is the Fat and Glandules which are at the top and on the sides of the Tongue; from these ways floweth a certain oily Liquor, which continually moisteneth the *Fibres*, for the freer motion of the Tongue. Besides, this diversity of the *Fibres* which we have mention'd, will not hinder us from placing the Tongue amongst the Muscles; for all these different Situations of the *Fibres* do only contribute to several motions of the Tongue. This appears also in the structure of the *Oesophagus*, the Heart, the *Diaphragm*, or *Midriff*. Which have each of their several kinds of *Fibres*, for their particular motions. It was then necessary that the Tongue, which is the Instrument of Speech, should have its several Beds of *Fibres*, of a different direction or Figure, to produce that variety of motions, which is so necessary for the Articulating of Sounds.

Asto the Nervous Tufts of the Tongue, some are of Opinion, that their small little Heads are covered thro' with any little Holes; it is a very difficult thing to be assur'd of this by the Eye-sight, yet with the help of a Microscope, one may easily and perfectly perceive them.

Having thus exactly view'd the Structure of the Tongue, we must now speak of the chief Organ of Tasting.

The Ancients were of Opinion, that the outer Membrane of the Tongue was the Organ of Tasting. According to others, it is the fleshy substance. Modern Authors pretend, that there is no other Organ of Tasting, besides the great number of nervous *Fibres*, which are spread insensibly thro' all the Tongue. Here's an Opinion, which is less probable than others, *viz.* That the *Amygdalae* and Glandules at the Basis of the Tongue are the Organ of Tasting. Wharton. whoever asserted that the Glandules contribute to the Sense of Tasting? The true Organ of it are those small Nipples we mention'd before.

Laurentius, Spigelius, Piccolomus, Casserius, Sennertus, Molinet.

Wharton.

particular Structure is very different from that of the Nipples of the Skin, those are of a Pyramidal Figure, and those of the Tongue on the other side have a Pedicle or Stalk, with a little Head on the top of it, bored thro' with many little Holes, to the end that the Particles of the Food may reflect, or shake the Nerves with more force towards the end of the Tongue, there where the Taste is more fine, the Nipples are more numerous than else where. Those Orifices of the little Heads, are (as we may so say) so many Tunnels which immediately receive that which is dissolv'd there, or melted from the Savours by means of the *Saliva* or Spittle.

This Liquor being enter'd into these Tunnels, communicates a certain motion to the Spirits, which is appointed by Nature for conveying the Idea of Savours to the Soul: For according to the difference of these Savours or Tastes, there follow different changes in the nervous *Fibres*, and in the Spirits. For example, if the Particles of these Savours do bind and contract the Nipples, this motion will occasion the Soul to perceive a sour Taste. If these Particles be sweet and oily, and so loosen the nervous Filaments of the Nipples by expanding them, we shall perceive a sweet Taste; and if they are Acid, these Acids by pricking the nervous Tufts, will give us a sharp Taste.

Now we see that there is something more particular in the sense of Tasting, than there is in that of Touching, since to cause the Sensation of Tasting, the Savours must pass thro' the Tongue, in order to pass into the Orifices of the Nipples; whereas in the Sensation of Touching, if the Objects only touch the Nipples of the Skin, it is enough to shake or reflect them. We have observ'd that the outward Membrane of the Tongue, was thinner or more fine in those Places where it cover'd the Nipple, there must needs be also an Infinity of small Holes, over against the Orifices of those nervous Nipples, for the easier passage of the savoury Particles.

If we squeeze the Tongue of an Ox after it hath been boil'd, there cometh out thence a certain green Liquor like the Juice of an Herb, which sheweth, that the *Saliva* or Spittle, which dissolveth the Particles

ticles of the Food, draweth a certain Tincture it, which passeth into all these Tunnels, in order to affect the Sensation of Tasting.

Having now seen the Modification which the different Savours or Tastes cause in the Nipples of the Tongue, we shall easily know why those who are away, are so soon recover'd, by pouring only spirituous Liquor into their Mouths, as the *Spice Wine*, or *Brandy*, &c. it is because these Liquors penetrating all at once into the nervous Tufts waken (as I may so say) the Spirits, by giving them a fresh Agitation, thus having recover'd their first pulsations or shiverings. they determine the Spirit of the Brain to flow afresh into those Nerves which belong to the Organs of the Senses, and the other Parts of the Body.

We have said that the motions of the Tongue did much contribute to the making of these Savours penetrate into the Orifices of the Nipples of the Tongue, for when we have a mind to taste any thing with satisfaction or pleasure, we move the Tongue round, that the Food may touch it in several places thence it is we have a better taste of what we eat, because the Juice of the Food doth not miss so much as one Nipple; and penetrating them all at once maketh the stronger Impression.

Some have thought, that the Tongue was not only Judge of Savours or Tastes, but that the Larynx, the *Oesophagus*, and the Upper Orifice of the Stomach had also their share in it. 1st. They say that these Parts receive the same Nerves as the Tongue doth. 2^d. That the Palate also tasteth the Food and that the Tongue in order to judge of Savours first strikes on the Palate, that it may thereby be excited to taste them more easily. 3^d. That Meats and Food have all their Savour or Relish, as they pass from the *Oesophagus* into the Stomach. 4th. That those Meats which have an ill smell, or are any thing disagreeable, do often dispose one to vomit, which is purely ariseth from the Irritation of the *Oesophagus* and upper Orifice of the Stomach, which have been offended with that kind of Food.

But since the Structure of these Parts is not like that of the Tongue, they can no ways be said to

Organ of Tasting, but only of Touching, as other Parts are. For Example, Pepper, by irritating the Palate with its Acridity, causeth there a great heat; it doth not make us sensible of the particular which we presently perceive by the Tongue; if the Tongue striketh against the Palate, for the finer judging of the Tasts, it is in order to press out the Spittle, by squeezing the Glandules of the Mouth together; wherefore Oxen and other Creatures which chew the Cud, and commonly feed on Hay, have their Tongue as rough as a Grater, to send, that by rubbing the Palate of their Mouths with more force, the Spittle may flow from thence in greater quantity.

They dissected a certain Man who chew'd the beginning of whose *Oesophagus*, and *Stomach* were full of certain small hard Knobs, like those on the Tongue of an Ox, which serv'd to facilitate his chewing of the Cud, but it was rather in manner a kind of a Card or Kemb, to card Wool, than the breaking his Food in pieces. In fine, the Relation of Tasting doth not pass farther than the Root of the Throat, and if sharp Wines, and high Season'd Meats produce any Sense below that, it is nothing but a tickling which depends on touching, and not on tasting.

Tho' the Tongue and the *Oesophagus* equally receive their Nerves from the first Pair, it doth not therefore follow, that these Parts are appointed for the same use, for the Structure of them is different. There followeth any disposition to vomit after eating too fat Meat, or Meat of an ill Taste, it is not in the *Pharynx* (or upper Part of the *Aspera Arteria*) that taste it; but it is rather, because as they pass, they irritate the nervous *Fibres* of the *Oesophagus*, and those of the upper Orifice of the Stomach; and that convulsive motion which happens thereby, is the cause of Vomiting.

We cannot doubt of the truth of what hath been said, if we only reflect, that we usually cast up whatsoever is disagreeable to the Tongue; one cannot scarce take any Medicine, or any thing that is a little bitter, but presently one is dispos'd to vomit, and we often cast it up, after we have swallow'd it,

because the Acrimony of them affects the Tongue in so disagreeable a manner, that they presently in the inward Membrane of the Mouth (which is continu'd from the *Oesophagus* even to the Stomach) a Convulsive motion which necessarily makes Vomit.

But we have found out a way to prevent this inconvenience, by palliating these Medicines with gar, or any other Thing to render them agreeable and more supportable to the Patient, that they not cause vomiting so soon.

Mr. Per-
rault *Phyl.*
Essays.
Tom 1.

After all these Reasons, we see that the Fa-
Drunkard of old, *Philoxenus* did in vain with his
Neck of a Crane, to have the more time, and
ter pleasure in tasting what he swallow'd: For
is certain, as we have said before, that the Sea
Tasting doth not pass beyond the streights of
Throat.

CHAP. VII.

Of the Sense of Smelling.

The Sense of Smelling hath a Medium betwixt touching and tasting, or betwixt seeing and hearing for it in touching and tasting, the Objects immediately touch their respective Organs, and in seeing and hearing, the Objects may be some-what at a very great distance; one may say that too well, the Objects must neither be too near, nor too great a distance, for if they are too near the sense, or too remote from it, one smelleth nothing, or very confusedly.

Philosophers hath left us no definition of smelling, excepting himself for this omission, because Man hath not an organ of smelling, so fine as other Animals. It is certain the Philosopher had some particular Reason which made him act after this manner, for certainly we know not so perfectly, the Nature of the sense, or the Sense of Smelling, as we do the senses of Touching and Tasting. It is also certain that most Animals and Birds have a much finer sense than we have, since they smell at a great distance, and are sensible of Odours, which we do not perceive at all. The Tygers for Example, have an exquisite smell, when the Females have lost their young ones, they go to find them out, by smelling as they go. Vulturs and Crows smell at a great distance, since being drawn by the smell of Carcasses they sometimes pass many Leagues. Hunting Dogs must needs have their smell in perfection to follow the Deer, and discover all their Tracts or Paths, without taking the change, and it is their smell purely, that they will distinguish their Master from all others, and that which is very surprising, and sheweth the wonderful Activity of their smell, is this, that in a great Heap of things, they will chuse out that particular one which is their

their Master hath cast there, or any ways
ched.

The Bees also among the Insects, perceive
smells of Flowers at a great distance, but to u
stand how they perceive it, there's the diffic
Mr. *Perrault* in his Mechanism of Animals, wh
the most curious Treatise of all his Physical E
pretends that Bees, common Flies, and many
Insects, which have not only the use of sme
but also of seeing or hearing, yet have nothing
one universal Sense, which is a very delicate T
for it being impossible that all the Objects of th
ferent Senses should be known, without some pa
lar motion, which may render them sensible
thinks, saith this Learned Naturalist, that tho
sects which are very small, must needs have
Particles which form the Organ of their Senses
smaller, whence the Organ is more easily shake
the motion of the Objects, let it be never so gen
slight, and much otherwise than in great An
where the Organ of Touching cannot be s
without some considerable motions.

The Ancients, who tried many Experiments
made many Observations on Bees, and every
that belongs to them, could never believe, that
heard the sound of the Brass. tho' they follow'd
ven *Aristotle* himself is of this Opinion. Sup
then that the Insects have a very fine delicate T
perhaps, that may be equivalent to the Organ of
ring in other Animals, that is to say, that the fl
of the Air, which is not perceiv'd by the Tou
great Animals, is proportion'd to that of Inse
that to explain what appeareth to us of the See
these small Creatures, we may say that if the Ex
tion or Vapour which ariseth from a dead Bea
from Honey or Sugar in a Box, is capable of
ing a Fly or an Ant at so great distance; it is al
Vapour which cometh from the Hand which dr
the Fly thither.

But tho' it be true, that some Animals have
ner smell than Man, we must yet observe that
are not capable of that variety of Odours as M
it is true, the Dogs have a Nose good enough
low the scent of the Beast, but they cannot per

cent of a Flower; on the other side Men distinguish all Odours or Smells, and perhaps, for this Reason it is that their Smells is not so perfect, as of other Animals, because Dogs and other Animals have not so many Occasions to make use of Smelling as Men have. In fine, it is in a manner with the smelling of most Men in general, as it is that of a Perfumer in particular, who being always in the midst of different and very strong Odors, is at last incapable of smelling any thing distinctly.

Some ascribe the defect of Smelling to the Abuse of occasion'd by ill Custom; they say it is with the Nose as it with the Tongue, for they who have been much accustomed to great Feasting, grow at last incapable of tasting any thing well, all those delicious Dishes or Meats in the end, do nothing but spoil and ruin the nervous Tufts of the Tongue; they who are accusom'd to Frugality, do in perfection, wonderfully distinguish all kinds of Savours and Smells, because their Organ of tasting is very easy, and soon affected or shaken. They say also that the true way of making good Dogs for the Chace, is to nourish them with Bread only, and not with Flesh or Meat, because the Odors of the Meat may weaken their smelling; therefore it is that great Hunters have their Dog-kennels at a distance from the Chace, that the Dogs may neither perceive the smell of kill'd or roasted Meats.

There's an extraordinary Instance, which seemeth to favour this Opinion: A little Boy flying into the Woods with his Parents for fear of the Enemy which had the Country, and having pass'd many Years in the Forrest, and feeding only on Roots, wild Apples and Acorns, &c. this poor Child was so habituated to all these kind of Nourishments, that he could not taste of the Savour or Taste of them, only by smelling to them, and by that he understood whether they were good to eat, or no. But that which is more remarkable is this; that by his smell, he was sensible of the Enemy, tho' at a distance, and advertis'd his Parents of it, who thereupon presently changed the place of their Abode. This Boy being at last taken by the Enemy, presently lost the delicacy of his

Sir Ro-
nelm
Digby.

smell, because being at their disposal, he was
 ged to live after another manner. It is remark
 That he still retain'd his former smell, tho' n
 that Perfection; by means of his smell, he coul
 stinguish the Woman to whose care he had been
 mitted, from all others, so that when she left hi
 any time, he presently found her again by his
 as a Dog doth his Master.

Seneca
 Hyppoli-
 sum. Act. 1.
 Scen. 2.

From this Example we may draw this Concl
 that if Men had continu'd in Forrests as their Fe
 thers had done, eating nothing but Acorns, and d
 ing nothing but Water, their Health and Cu
 would not have been so much corrupted. For
 who had consecrated the Flower and Innocen
 his Youth on the top of a Mountain, would
 have been puffed up with the Leaven of Amb
 nor blasted with the Canker of Envy; he
 neither have had Complaisance for the Grand
 this World, nor would he have desir'd to have
 of their number; Favour which charmeth an
 priseth others with its Lustre, would have had
 fluence on him; and Riches, in the pursuit of
 the whole World is taken up, would have ap
 too uncertain to have amus'd, or stopp'd him
 course of Life.

As he would have been without hope, so
 would he have known what Fear was, as he
 have envi'd none, so neither would he have be
 vied by others: Thus having had no Passions
 own, he would not have been subject to those
 ther People, nor would he have been so much
 acquainted with the Place where Crimes dw
 keep their Abode. Noise would not have start
 Conscience, nor would his Words have any w
 olated it; and his Tongue and his Heart woul
 understood each other so well, that his Heart in
 pose he would have then enjoy'd, would hav
 always in Consort with it self.

To see with what Satisfaction he would ha
 joy'd the Country, one would have thought
 been the true Owner and Master of it, and t
 he would have breathed, would have been
 as his Life. All his Artifices, Politicks and O
 would have been employ'd in Hunting the

and when he had been tir'd or wearied with noble and laborious Exercise, he would have laid himself under the shadow of some old Oak, have quench'd his Thirst at the first Brook he met with; sometimes he would have took one to walk in, sometimes another. There the Notes of the Birds, and the noise of the Leaves blown by some gentle *Zephyrus*, would have charm'd him with a Confort, equally agreeable and natural. Then a Bed of Virgin Turf and green Moss would have invited him to a Repose; nor would he have lain long there, without being lull'd asleep by the murmuring of some gentle Brook, which would have seem'd to groan and lament, not so much for its having been so far from its Head or Fountain, as that it had quitted the pleasant Meadows which had em-
bellish'd it.

Upon his waking he would have first wash'd his Face, and with that natural Glass, which is more perfect than all the Cups of Gold and Silver, would he have quench'd his Thirst, and would as easily have satisfied his Appetite, by only shaking the next Morn'g. Thus without any Assistance, except that of his own Hands and Arms which certainly would have been very obedient to him, he would have been more content, than all the Kings and Monarchs of the World, which are too often troubl'd, and sometimes betray'd with the Croud of their Servants. He would not have sought out any obscure Place, in order to rob others, nor would he have been led into any Maze or Labyrinth to have committed Adultery; in fine, Heaven would have been witness of all his Actions. Thus liv'd the Heroes of the first Age, and theirs was call'd, *The Golden Age*.

Tho' this digression may in some Men's Opinion, seem too remote from our present Subject, yet it comes in naturally enough, because it is certain that all the Organs of our Senses are entirely depriv'd by the Commerce of Mankind; we have too great an Experience of this truth.

To return again to what we have said about the Perfection of Smelling; tho' it be true, that Cooks, Perfumers and Apothecaries being always amongst a

R: 4 great

great variety of strong Odours or Smells) do rec-
 so many Particles thereof, that their Smelling is com-
 monly thereby depriv'd, and much impair'd, and
 others, who are not so conversant with these Odo-
 are more sensible of them, and even at a distance
 yet we must not therefore believe, that Men
 naturally speaking, their Smell so fine as that of
 Animals.

A Humane Nose, and that of a Dog, are of a
 ferent Structure; in a Dog, and in most Brutes, we
 have a finer Smell than Man, the Membranes
 Bony Plates which support them, are more nu-
 ous, and rowled up like a Cornet or Coffin of
 per, for the having a great Extent in a little
 These Cornets are call'd *Ossa Turbinata* by Ca-
 an Italian Physician.

Now the Organs of Smelling are nothing but
 thin large Membranes, extended on small Bone
 thin as so many little Leaves. These Membranes
 are streak'd with Joints, which are the Veins
 Arteries.

A Man's Nose is proportionably much finer
 than that of other Animals: There are not so
 little Leaves, nor are they rowled up so artificial-
 they are in Greyhounds, Lions, and Tygers
 thus a Man hath not so perfect a Smell. The
 Man maketh no Debauch at all, nor committe
 ny Excess, it doth not therefore follow that he
 have a good Smell; we see several Peasants who
 ver knew what Feasting and delicious Fare
 whose Smelling was never yet the finer for that,
 many who have spent their Life in feasting, have
 retain'd a good Smell; this Perfection then of S-
 ling doth not always depend on a sober and mod-
 Way of Living, but we have this Disposition
 of Birth, yet it may be much alter'd or im-
 red, by a too frequent Use of strong Odour
 Smells.

If the Smelling of Grey-hounds is much
 en'd by the Vapours, which arise from Boil-
 Roasted Meats, they will have it still much
 impaired by their being shut up in the Stable
 the Horses, because of the gross Vapours
 come from the Bodies of the said Horses. W

to observe, that they lose the Custom of smelling their Masters, nor such Beasts which they chase: Thus we must further explain, why they bound, after he cometh to be fed in a Kitchen, not a Smell strong enough to perceive a Dog, or a Deer. Here's the reason of this Phenomenon, they say, that those Dogs which are always in the Smoak and Vapours of Meats, must needs have a weaker smell, because their Nose acquireth such a Disposition, that it cannot be any ways sensibly Affected with any Smells or Odours that are weaker, or not so strong; therefore if you put any other Dogs to pursue the Track of a Beast, they will not follow the Scent, because the Vapours of it fill up two small a quantity, to make any effectual Impression on their Organs, which are not moved, except without an abundance of savoury Particles.

For this reason it is, that Boyling and Roasting-houses, Perfumers, &c. whose Organs are continually affected with strong Odours, at last grow insensible of Smell, or Odours, which are less strong. By the same Principle, we shall give a reason why Drummers and Ringers, who have been long accustomed to great Noises, are, in a manner, insensible of small Noises. They do not hear you at all, unless you bawl aloud in their Ears. We observe also, that they who are accustomed to much Light, do not see so well in places which are any thing obscure.

But Nature hath granted to Brutes a certain Advantage which we seem to want, since they excel us in Smelling, yet we have no reason to complain: For tho' there be a kind of Imperfection in us in relation to this Sense, yet in recompence thereof, we have a much more delicate Taste and Touch, which is a greater advantage, and this Brutes have

perhaps, their not having these advantages, is the reason why they have so fine a Smell, which was necessary for them, in order to chuse their Food, and to distinguish what was proper for their Nourishment, and to shun what was Destructive: For we observe, that Brutes always Smell to any thing before they

they Eat it, especially when it is such Food as are not acquainted with; whereas we Taste the Judge of their Goodness. Brutes are not much taken in the choice of their Nourishment; they perfectly distinguish what they are to Eat, and they are to let alone; whereas we, on the contrary, are convinc'd, by our own Experience, that our deceiveth us in many occasions, making us Eat such things as are Destructive, or contrary to Health.

This difference doth not yet any ways lessen the close affinity, which is betwixt Tasting and Smelling, nor hinder its being of as great help to us, as to other Animals, in order to our knowing and choice of the Food we take, and which we Examine by Smell, which is so much the easier to be done, because of the Extraordinary affinity betwixt Smelling and Taste, since the Smells arising from Meat or other Foods are nothing but the more refin'd Particles of the hal'd and striking on our Nose, and Taste are of the grosser parts of the Food. It is the volatile and phurous Salts of the Food, which first affect the Nose, and the remaining parts of it are fixed in respect of the first, they cannot get loose from themselves, or be dissolved, without the assistance of the Spittle, which melts them in our Mouth.

Besides, nothing doth better Demonstrate the affinity betwixt Tasting and Smelling, than those common Rheums and Catarrhs: For Example, when a man hath got a Cold, one scarcely perceiveth any Taste at all, and one's Taste is but imperfect; which proceedeth not so much from this, that the Nerve of the Tongue, and the Lips, have the same Nerve (as it is commonly urg'd) but from this rather, that an Obstruction can happen in the *Membrana Pila* of the Nose, but the Tongue must needs be affected by it also, being so near it.

It plainly appeareth from all that hath been said, that Odours are not only simple Qualities, but they make themselves perceiv'd by an inward shaking of the Membrane of the Nose, or rather by the Nervous Tufts thereof, but rather some essential Effluvia of Bodies which smell, when they are clear'd from the Air, do stick to the Me-

Nose, just in a manner as Silver, after its dissolv'd in *Aqua Fortis*, clings to the surface of Copper, which are us'd to separate Odours or Smells are of so volatile a Nature, they are easily carried off from their respective places, by the motion of the Air, and the *Materia* and even as Spittle is the Menstruum or Dissolver of the Salts of the Food; so also Air is the solvent and Vehicle of the volatile Salts, and Echoes of Odours, of which Odours are composed. This is which carrieth them on to the Membrane of the Nose, and giveth them that motion, which is the Nerves and Spirits, by producing in these Undulations or Shiverings, which are necessary to communicate the Sense of Smelling to the Brain.

which proveth that Odours are Substantial Qualities, flowing from Bodies, is this, 1st. That to recover one's Strength, just as if one had swallow'd any body or part of it from whence they are deriv'd. The Smell only of Alexiterial Remedies or Agues, is often strong enough to prevent contagious Diseases, in the same manner as if one had taken the Medicines themselves in Substance. 3d. We find, by Experience, that the Smell of Musk makes the blood fresh, as much as if one had taken it into the Mouth. 4th. If you rub the hinder part of the Neck, or any other part with any strong Smell, as *Cypress*, *Castor*, *Musk*, &c. the pains cease. We confess, that it is very difficult to explain these kinds of Facts, without the Hypothesis of Corporeal Effluvia. 5th. One is no sooner entered into a Garden where there is an Orangerie or Set of Orange Trees, but the Wind presently bringeth the Odour of them to us. 6th. They who Sail towards the Isles of *Coslan*, tho' they are many Miles from it, yet perceive the Smell of *Cinnamon*, which would be, were this Odour only a simple Quality, and not the Saline and Oily Particles of the *Cinnamon*, and *Peppercorns*, which the Wind carrieth off. 7th. The *Indians*, and those of *China*, have a Custom to preserve the Odour of Musk, by wrapping it up in a Skin, which hath been steep'd in stinking Urine; the Salts of the Urine which hath penetra-

ted

ted the Leather, keep the Particles of the Musk that Agitation, which is necessary to preserve Odour. 8th. When the Air is overcharg'd with strong Vapours, one can hardly Breathe, one seems to be almost suffocated; which proceedeth from that the Pores of the Air are so filled, that it cannot exert its Spring, when we Breathe, and thereby much heavier than it should be, it meets a great resistance to the motion of the Breath, fine, all who are always conversant amongst Odours have their Noses so full of them, that there is one point of the *Membrana Pituitaria* which is filled up with them; and therefore when they Smell other Odours, they find no Impression of there being no room left to receive it, and as they are reflected or beaten back again, one cannot Smell any thing of them.

Many Objections have been formerly made against what we have here formerly advanc'd; they ask Is it possible that a Grain of Musk should fill a great space with its Odour, for so long a time yet without any diminution of its Bulk. It is answered this, by saying, that it is the extream fineness of the Odoriferous Particles, which is the cause of the diminution of the Musk is so little perceived. The Air also, which is join'd to the Subtlety of the Parts, spreads them every where about. Here is an Instance which will confirm what we have Advanc'd on this Subject. Dissolve a Grain of Copper in *Menstruum*, there will be enough to give a Tincture to a great deal of Water; so a grain of Saffron will make abundance of Yellow.

We must yet observe, That the Odours more or less subtle, or more or less extream must needs produce a sensible Diminution of weight, more or less. If you weigh those which have sent forth their Odours for a long time tho' they seem to be of the same bulk, they have yet the same weight. This Experiment hath been tried with some particular weights, made on purpose for it, and it hath been found, that it is not only Odoriferous Bodies, or such as send forth Smells,

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In fine, to say that all Odours consist in the Evaporation of the Particles of a mixt Body; there is need of proving this any farther, for there are things which give no Smell, unless you burn or rub one against another; for Example, *Spanish-Wax* has no Odour when it is lighted, but otherways no Smell at all.

Whatsoever is Sulphurous in mixt Bodies, is the Basis of all Odours, for all Odoriferous Bodies are, in manner inflammable or easily take fire: *Castor*, *Camp* and all other things of this kind have only an Odour because they have much Sulphur in them; and if you draw off the Sulphur of a mixt Body by Distillation you will take away the Odour of that Body. But Sulphur is the Basis of Odours or Smells, Salt is a principle of it. This is it which giveth action to the Sulphur by clearing and disengaging of it, and cause the Particles of it being very massy, as soon as they are agitated, they communicate much motion to the Sulphurous Particles.

Odours then depend on a certain proportion of Salt and Sulphur; it must be all Volatile, in order to be Evaporated into the Air, that the Air and Sulphur matter which cross thro' the Pores of the Odour may carry off the finer Particles of it, which have a Connexion or Adhesion to the others, just as the Wind which passes thro' a Hedge, carrieth off the light things which are there, as Straws and Leaves which stick there.

Besides Odours do not always Smell alike, but depends on the Temperature of the Air; if it is too subtile, too hot, and too cold, it cannot any way contribute to the evaporation of the Odours; for if it is too subtile, or too hot, it hath not so great a Spring, so that it is not able to separate any thing from the Bodies, just as Fire goeth out, when there is no Air at all, and when the Air is too cold, it is a great hinderance to the Evaporation of Odours, because it is too heavy, therefore the Odours are very agreeable at Noon, because of the great heat about that time of day, nor in the Night because it is then too fresh or cold: They are always most pleasant in the Morning and Evening, for there is no wind coming into a Garden in the Morning, where *Jessamine*

Evaporations and Tuberous are, but every thing seemeth to be intended.

The Mouth and Nose are filled with Air, yet we are sensible of Odours only by Respiration. Here is an Experiment to confirm it. Make a small Orifice in the space betwixt the Rings of the *Aspera Arteria* in a Living Dog, as is commonly done in a Cholomy. Take care to keep the Ulcer fistulous, as the Air of Respiration is determin'd to pass thro' this Orifice, and that it passeth not thro' the Mouth. The Animal looseth his Voice and his Smell at the same time. By this it appeareth that Respiration is of great Importance for Smelling; the Odours which are spread in the Air, are too weak of themselves to be perceiv'd, they must be gather'd together and reunited on the Membranes which are within the Nose, and for this reason Respiration is so necessary for fixing the Odours on the Membranes.

The quick motion of the Air is also of great Importance, to render the Action of the Odours more prompt and speedy, not only by fortifying the impression of them, but also because the Air being removed from one Membrane to another, turneth round in so many ways, that the Odours in an Instant, may everywhere touch the little Leaves or Membranes the one after another, which it could not do otherwise, for a long space of time, the Air repoling in the Nose, when one breatheth no more; and thus the Air which is contain'd in the Nose remaineth useless, without Action, because it is too remote from the Membranes of the Organ of Smelling.

It being necessary that the Air which carrieth the Odours or Smells should be agitated, hath something in it like that which happeneth in Tasting; the Food, as we have before observ'd, must be moved in the Mouth several ways by the Tongue, that the Savours may every where touch the Nerves, which are on the Organ of Tasting.

Some have maintain'd, that Respiration was not necessary for smelling, and that one might perceive the Odours without breathing; because say they *Casseri*, Respiration contributed any thing to the Sense of Smelling, the principal or chief use of it had been for Sensation; is it not evident, that Nature never intended

intended Respiration for any thing but the refreshment of the Heart and the Lungs, it is an idle thing to make it serve for Smelling. They add, that Odours pass into the Nose, without being there by the Air, and that Women who are subject to Hysterical Vapours, and faint away when respiration is any ways hindered or stopped, are yet sensible of Smells, since they are often recover'd from those Fits, by smelling to some stinking or Odours. In fine, they believe according to the opinion of the Ancients, that the *Matrix* is sensible of Smells, and that it is false, that holding one's Breath, one is insensible of Smells.

But suppose we allow Respiration to have the use which we would ascribe to it, what should we say but that it may contribute to smelling also, may the same numerical Action serve for several purposes? The Tongue which is the Organ of Tasting, is not also the Organ of Speech? It is true, that Odours enter of themselves into the Nose, but to make an impression on the Organ of smelling, the Air must be pump'd in at several times, without which Odours would not be gathered together on the proper Organ.

As for those Women who are sometimes seized with these Vapours or Hysterical Fits for a long time, tho' these stinking smells bring them to themselves, it is not because they Smell them that they are recovered from this kind of *Letargie* (for in this case, are often depriv'd of the use of all the Senses) but we must rather say, that these Smells can never approach the Nose, without vibrating the Inward Membrane of that part of it, which is very sensible; and this Irritation communicates certain Undulations or Shiverings to the *Spirits* which presently pass into the *Genus Nervosum*, then the Women begin to perceive the Smells according as they recover from the State they were in.

These Smells have the same effect on them as cold Water which is cast in the Face of one who fainteth away; this particular *Phenomenon* being plain'd elsewhere, I shall insist no longer on it.

How could the Antients assert, that the *Matrix* is capable of perceiving Smells? It is true, that men feel it move up and down sometimes upon applying of spirituous and penetrating Fomenta to the Belly; but this doth not prove that *Matrix* is sensible of these Odours, no more than the Stomach is sensible of them, when we apply Volatile and Aromatick Medicine Outwardly to Fortify or Strengthen it.

And if it is said, that one may perceive the Smells when one holdeth one's Breath, but they do observe that this is an effect of the Inspiration which one hath first made, which hath carried the Odours to the Nose, the impression whereof continue, for some time, without Breathing a-

Let us now see what is the true Organ of smelling. Those Animals which have a long Snout, have their Smell very fine and delicate, which sheweth that the chief Organ of this Sense is not within the Brain, as (with the Antients) even at this time we do believe, but this Organ is on this side of the *Palmoideis*, within the Cavity of the Nose, since the *Nervi Olfactorii* take their rise from the Basis of the *Corpora Striata*, by a certain Marrowy substance of Fibre, which groweth something big there where they make a winding near the *Optick Nerves*, afterwards they pass thro' the *Os Cribrosum*, with an Army of Branches extended on those Membranes which cover the Bony plates of the Nose, which are the true Organ of smelling.

If it were necessary that the Air of Respiration should pass into the *Cranium*, to Touch the Organ of smelling, the length of the Pipe or Conduit which should convey this Air, would rather hinder than assist, than render it more perfect, and the Air would lose much of their force, by so long a Passage. Tho' the *Apophysis Mamillaris* is bigger in Brutes, and hath a certain Cavity which is not in Man, this proceedeth purely from the small little Threads of the Nerves, which come out from thence, and which are still proportioned to the bigness and extent of the Membranes of the Nose.

As to the sensible Cavity of the *Apophyses* Man in Brutes, we do not pretend to determine anything of the use of them. Mr. *Perrault* saith it serveth them as a Ventricle, which, as one say, is particularly necessary to those parts, be of their extraordinary bigness in Brutes; but teacheth us nothing of their use, since some that the moistures of the Brain are strain'd thro' Cavities, in order to pass from thence thro' the of the *Os Ethmoides* into the Nose; but we have elsewhere, that that Passage is too well stor for any such purpose; besides, to reason after manner, one must be ignorant of the use Glandules.

Others will have it, that these Cavities do contain a certain *Lympha*, which serves to moderate strength of Smells; but we have already observed that these Cavities lye like the end of a Bag on the side of the *Os Cribrosum*, therefore nothing passeth beyond them. In fine, it is an to Imagine that the Ventricles of the Brain, in natural State, do contain any *Lympha*; so there is any found there, it proceedeth from Disease, or some kind of Death. There's no necessity of insisting any longer on this point, let us on to Matters which are more useful, and let us consider, why the inside of the Nostrils is the Organ of smelling.

First, In Man the Nose doth something strange more or less, but in Brutes still to a much greater degree, to the end that those Membranes which are the immediate Organ of smelling, may be able to receive a stronger Impression of the Odour. 2d. Since the bigness of the Nose of a Man is greater than of other Animals, is necessary to promote or improve smelling, it follows from thence, that those who have flat noses, or have lost their Noles, smell but imperfectly. 3d. In those filthy Ulcers of the Nose (call'd *Azenæ*) in case they lye deep, the Sense of smelling is not lost at all, tho' those who are afflicted with it, do not perceive the Smell of the Ulcers. 4th. The structure of the Bony plates of the Nose, which are cover'd all o'er with Membranes, clearly sheweth, that the Nostrils are

simple passages to let out the Air of Respiration,
 the old Anatomists Dream'd, but that they are
 Magazine for Smells. 5th. The inward Mem-
 brane of the Nose is of a structure which is diffe-
 rent from that of other Membranes, as *Casserius* hath
 observ'd, who calls it the fleshy Membrane from
 its softness; tho' it be only a Continuance of the
 Pia Mater. The Substance thereof is
 spongy, and beset with Nipples so very fine
 and delicate, that there's no wonder that such subtle
 smells as those of Odours, should be capable to
 pass through them.
 It hath been said, that this Membrane in those
 Animals which have a very fine Smell, doth every
 day follow, or approach the Spirals or Windings
 of the Bony Plates of the Nose, which are very nu-
 merous in the *Tyger*, and the *Vultur*, &c. He who
 made this curious Observation, saith, the reason
 why this Membrane hath so long an extent, in so
 small a place, is, that it receiveth many shakings from
 the Air all at once.
 To put an end to this Subject, we shall observe, *Mr. Steno*,
 that the late Anatomist did not well comprehend the *Myologie*
 of *Casserius* on the Organ of Smelling; he *Diamer-*
 confute without understanding him, when he brook.
 that he is mistaken by ascribing the Organ of
 Smelling to the fleshy Membrane of the Nose; but *Cas-*
 sarius is quite otherwise, for he doth not only, with
 the old Anatomists, make the *Apophyfis Mamillaris* the *Cl. 17.*
 Organ of smelling; but he also warmly answereth *Set. cl 18.*
 those who is a great Champion of the Modern
 Opinion, according to which the principal Organ of
 Smelling is that Membrane, which covereth the Bony
 Plates of the Nose. In fine, this same Author pre-
 tends that the Membranes of the Nose have no other
 use but to temperate the Air of Respiration; thus
 very far from thinking (as some Represent him)
 that the inward Membrane of the Nose is the Organ
 of smelling.

CHAP. VIII.

Of the Sense of Hearing.

THE Sense of Hearing differeth from the Senses which we have hitherto mentioned, in respect of its Organes, because the objects of Touching, Tasting and Smelling, do an immediate Impression on their respective Organs without causing any considerable Modification of them. But in the Sense of Hearing it is the Ear receiveth the Sounds at a distance, Modifieth and giveth them such an Impression as is capable of producing this particular sensation.

From thence we may judge, that Sounds have a great Sphere of Activity, since we hear at so great distance; yet we must not imagine, as *Lucretius*, that Sounds have a larger extent than Odours: The Instances which we have where we treat of Odours, shew us the contrary. Some have maintain'd, that one may perceive at several Miles distance, and that we cannot hear the sound of the greatest Bell or Cannon at a Mile or Two; yet, if we compare that distance which is betwixt the Origin of the Sound and our Nose, with that which is betwixt the Sound and the Ear, we shall find that the Sphere of Hearing is of a much larger extent than that of Smelling. For the only reason that we smell Odours at a distance is this, That they are brought to our Noses by the Wind, on the other side they receive nothing from those sounding Bodies, but only that vast expanse of Air which is betwixt the Body which giveth the Sound, and the Ear. I say, this Air, which by a strong Impression moveth the Membrane of the Drum, by Touching it immediately: Thus Hearing is performed as Touching, even as it is in the other Organes and Senses.

is with Sound, as it is with other Sensations. There are two things to be considered in relation to Sound, the Idea which is formed in the Soul on the occasion of sounding Bodies, and that which is the Body, which foundeth as in a Bell, and in the which it shaketh.

After what we have already observ'd, where we speak of Taste and Smells, it is needless to say, that taken in the first signification cannot be denied, and that we have no knowledge of it, but by experience; therefore in this place, we take it only as signifieth what is in the sounding Bodies, and in the capable of shaking the Organ.

It is a false faith, that Sound is nothing else but the motion of certain Bodies, and of the *Medium* which affecteth our Ears. We have some reason to surpriz'd that his Followers did not understand at all, since they confidently assert, that Sound is a quality different from local motion.

Most of them have reason'd so childishly, that they have rendred themselves ridiculous by it; some have said, that if Sound was nothing else but local motion, it would follow, that in moving the Hand, I should hear a Sound; others have thought it impossible that the sound of a Bell, which is heard at Leagues, should proceed only from the shaking of the Air; but one may easily perceive, that sound can be made without local motion.

All Musical Instruments make no sound, unless they are Touch'd. 2d. In most Effervescenties or fermentations, there is a little kind of a noise which is purely from the shivering of the Particles of the Body, and the Air. 3d. Sound is heard at great distance. 4th. There is no discharging of a body without shaking every thing that is near it, or the Agitation of the Air, which is caused by which often break the Windows. Now can all this happen without a local motion? Yet all Bodies which are in motion, are not therefore capable of making a Sound, because they have not that particular determination of motion, in which Sound consists.

When the School-men assure us, that a Bell can move the Air at two Leagues distance, they do not consider, that we do not so much insist in the giving

giving of motion to the Air, as in determining it hath already receiv'd.

We cannot conceive (with *Aristotle*) that in order to make a sound, we must always have a polish'd and hollow Body, all the World is sens'd that there are many Bodies without these Conditions which yet are capable of making great Sound *Water, Air, Gun powder, Aurum Fulminans*, and fine, in many other things, which yet make great Sounds, tho' they are neither hard, smooth nor hollow; so that methinks, the nature of Sounds consists not so much in the motion of some kind of Body, as in the particular manner of the motion. In effect, we see by Experience, that all motions are not proper to produce Sounds, but must be quick and nimble, to give these shivers to the Air. For Example, the simple moving of a Hand in the Air produceth no sound, because it pusheth the Air, without giving it any other motion; but if one clappeth one's Hands, one makes a Noise, because in so doing, we communicate to the Air that particular motion, which maketh a Sound. Thus it is, when you pinch the String of a Lute slightly, it giveth no Sound, but if you touch it with more force, it will presently move the Air. As a Stick and a Switch make no noise at all, when they are mov'd gently in the Air, on the other hand, if they are mov'd with force, they make a kind of whistling in the Air. So it is also in the Fermentation of Liquors, if the motion of the Particles is gentle, you have no noise; but if the Particles rub hard against each other, we hear a sharp, harsh noise which offends the Ears.

Now the motion of sounding Bodies doth not immediately reach the Ears, the Air then must first receive the Vibrations of it, which will be more or less strong, according as the Spring of those Bodies is more or less strong. The Air is very proper to receive the Agitation of Sounds, because being compos'd of certain Elastick Particles, it more easily receiveth the shaking of those Bodies which make Sound. If you turn your Finger round the Bottom of a Glass, half full of Water, one may see it tremble and boil up, as I may so say, and some drops

it. If Water is capable of receiving this trem-
 and agitation, with much more reason will the
 be capable of this motion, since the Particles of
 are a much greater spring than those of Water.
 Water also as well as the Air may be so agitated, as
 make a sensible Noise. When one is at the bot-
 of the Water, one still heareth the noise, which
 about the Water, tho' but softly, the shaking
 the Water receiveth, proceedeth purely from
 Air which toucheth on it, and in the same time, the
 shaketh the Membrane of the Drumb, something
 weaker degree, than the Air is us'd to do. But
 is once so many Fathoms under Water, one hea-
 nothing at all; this was confirm'd by the Experi-
 of the famous Diver, who went down to seek
 the Cannon and other things belonging to a Ship,
 was sunk to the bottom of the Sea; he did not
 the Cannon which were discharg'd, because he
 too much Water over his Head, he received no
 from the Water, because the Water is not
 able of being agitated by the Air, unless it be at
 main distance, which is much lesser in the Wa-
 than in the Air.

The Sound is not only brought to our Ears
 the means of Liquids, but also by Solids. If
 knock never so gently at the end of a long
 or piece of Timber, that agitation will
 easily pass to the other end; and if you put
 your Ear close to it, you may hear a considera-
 noise, which purely proceeds from the successive
 motion of the *Fibres* of the Wood, so also if we put
 out, or a little Ball, or any thing else into a Box,
 shake it up and down, we shall hear a noise,
 that which is in the Box, strikes on the sides
 from whence the motion is communicated to
 Air, which is without the Box.

The hardest and most solid Bodies, as Mettals
 make the greatest resistance to motion, are yet
 capable of receiving that Agitation which ma-
 Sound. The truth of this appeareth by a great
 for it shaketh or trembles at the least stroak
 the Hammer on it, and if you put some *Millet Seeds*
 and then strike on the sides of it with an indiffe-
 ring Key, according as the sound is greater or les-
 we may see the *Millet Seed* dance up and down,

and change their place more or less on the Air. Now this could not happen so, unless all the Particles of the Mental did make a kind of a spring.

It is no hard Matter to demonstrate, that the particular Agitation of the Air, in which Sound consisteth, is only fit to touch, or affect the Ear, and no any other Organ, for the Air being stirr'd by the Wind or by a Fan, &c. maketh no noise, tho' one may perceive it, and if the Wind maketh any noise it is purely by striking or shaking of other Bodies.

Mr. Per-
rault *Phys.*
Essays
Tom. 2.

That particular Agitation of the Air of which noise is form'd, consists in two things, the small space and the quickness or velocity of the Time in which it is made. By space here, we do not understand that which lieth betwixt those Bodies (which strike against each other) and the Ear, for this may be a very great space, but the space we mean, is that in which each Particle of the Air is agitated, so as to strike the first part of the Air which is put in motion by the stroak of the Bodies, and the last which strikes on the Organ of the Ear, as well as all the others which are between those, each of them take up but a very little space, which is not so in other motions of the Air; for in a Wind each Particle of the Air passeth thro' a very long space, just as it is in the motion of a running Stream or River, whereas the small space which is supposed in the motion of each Particle of the Air, is something like that which passeth from so many little Bowles, placed in a right Line. If you strike the first of them, you move the last by putting all the others which are betwixt them into Agitation or Motion.

This same comparison may help us to explain the swiftness of the motion of the Particles of the Air, for if one pusheth the first Bowl gently, the last will hardly stir, and the Bowls which lye betwixt them will turn on one side; on the other side, if you give a vigorous and brisk stroak on the first Bowl, the two Bowls which are betwixt them, will have no time to turn aside; by the same reason those Particles of the Air which push each other, in order to transmit the motion of the sounding Bodies even to the Ear, must have a very quick and vigorous motion, to prevent their having any leisure of turning aside.

All the outward Part of the entrance of the Ear, winding and crook'd, to this end, that the Sound may make a stronger impression on the Organ of Hearing, these windings encrease the force of the Sound, multiplying its Reflexions. These Agitations of the Air being at first extended at large, are gather'd together by the outward Ear, as with a little Horn, therefore in Man it is hollow, and something binding outwardly. The Ears are not plac'd on the sides of the Head for Ornament or for defence, but purely for the Air which cometh there, may be reflected against the Edges of them, in order to enter into their windings.

It is evident that the outward Ear serves for nothing but to recollect the Sound, and direct the impression of it toward the Conduit of the Ear: This we daily observe by those Animals which turn their heads to that side on which the Wind bloweth. They who have lost an Ear, hear but imperfectly, therefore they are forced to form a kind of a little Horn with their Hand, or to make use of an Artificial one for the recollecting of the Sound. Deaf Persons do also make use of the same shift. Now to the end that the Air may be the better reflected on the outward Ear, it is form'd of a thin stiff Gristle, cover'd o'er with a certain Skin which is fasten'd betwixt the Bone by a Ligament and Muscles; those Folds of the Ear serve to reflect the Air, as we have said before, even as Trumpets serve to augment the Sound, by the various reflexions of the Air in the windings of those Instruments. The Folds of the outward Ear are very proper also, to moderate the violence of Sounds, to preserve the Conduit of the Ear and the Drum-skin, and to defend them against any thing that may fall into the Ear.

The outward Conduit of the Ear is divided into three Cavities, the first is called the *Concha*, because it resembleth the Mouth of a Snail-shell, this is properly call'd the *Vestibulum*, or Porch of the Conduit or Passage, which leadeth to the Membrane of the Drum. This Conduit is partly Cartilaginous and partly Bony. The Cartilaginous Conduit is form'd of the narrow part of the *Concha*, it is about five Lines long. All the Pipe is cover'd o'er with the Skin, which

which is before the *Concha* ; there are several yellow Glandules under it with an oval Figure, of which is furnished with an Excretory Pipe which opens into the Cavity of this Passage. Here that low and viscous Matter which is in the Passage of the Ear cometh out, whence the Ancients called this part the Hive.

The bony Part of the passage of the Ear is a Part which seemeth to be join'd to the Bone of the Tempore at the end of which, the Cartilaginous Pipe is fastened. The Orifice of it is an Oval Figure, and as it cometh forward, it groweth flat. The Drumb-skin which divideth the outward Ear from the inward Partition-wise, is at the end of the Bony Conduit. But here's a very curious thing, and worthy of Observation.

Whilst Nature is busied in the growth of the Infant, and in fortifying all the Parts of it in its Mother's Womb, the whole Conduit of the Ear remaineth all Cartilaginous, in order to preserve the Membrane of the Drum from that Liquor which flows into the Ears of the Child, as it doth into his Mouth and being gathered together there, might, perhaps grow sour, and so prejudice this Skin, had not the wonderful Contrivance of Nature prevented this inconvenience.

In the fore part, or before the Drumb-Skin, there goeth another Membrane stretched all about it ; this Membrane is strong and something thick, for the better resisting of any thing that might hinder the perfection of the passage of the Ear. The cause why young Children do not hear so well as when they are more grown up, proceedeth from this Membrane and the Conduit of the Ear, which is all o'er Membranous. At last this Vail necessarily disappears, thus it happeneth. The lower part of the passage of the Ear growing hard and Bony, and the upper part which is Cartilaginous, being raised something higher, the Membrane which covereth the Drumb-skin, and which is fastened to the sides of the Cartilaginous Conduit, by its being too much stretch'd or extended at last breaketh, and this Curtain being torn in pieces in the end disappeareth.

This Membrane perhaps is often the cause of Deafness, for by the resistance which it maketh against the efforts of the Conduit, thro' the occasion of its thickness it continueth in the same state; afterwards it encreaseth with the other Parts, and being thus were glued to the Drumb-skin, they both of them make but one Barrier, which renders one deaf for the rest of one's Life.

This is not then the Drumb skin, that is the chief Organ of Hearing, since we find by Experience, that if we bore it thro' in a Dog, the Dog will retain his Hearing for sometime, but it will be something impaired, and at last entirely lost; the same thing hath happen'd to these, who by holding of their Breath, have made so great Efforts as to break this Membrane. Some perhaps, only for the fancy of blowing out the Candle, and others to blow the Smoak of Tobacco into the Ear, but in the end most of them grow deaf, or hard of Hearing.

This Membrane of the Drumb hath its particular Use, just as a Sash Window, whose transparent Glass letteth in the light but keepeth not out the too great heat, and so cold at the same time, so also the Drumb-skin seemeth to communicate only those Vibrations, which it receiveth from the Air to the Drumb, and yet tho' this Membrane serveth for no other use than what we have mention'd, we observe, that upon the least disorder or indisposition of it, several Alterations happen in the Ear. For Example, in any Distempers of the Ear, if one hath made use of too cold, or too hot, or too strong Medicines, the Drumb-skin will either be too loose, or too extended, nor will it receive the Impression of common Sounds but imperfectly; for we must observe that this Membrane is already somewhat convex within the Cavity of the Drumb, because it is extended by the Muscle which belongeth to the Handle of the Hammer. If then this Muscle happeneth to lose its Spring, the Drumb skin will certainly retain its natural Tension no longer, so that it will not be in a condition to receive the Impression of moderate Sounds. This Relaxation of that Membrane, perhaps, is the cause of that Deafness, which some Persons are troubled with, who hear nothing but great noises, as that of Bells, and the like.

like. Here are four famous Instances to shew, one is apt to grow deaf upon the relaxation of Drumb-skin. The two first are taken out of *W* and the two others from the Journals of *England*.

The first giveth us an account of a certain L who could not hear at all, unless one beat a Drumb very loud in her Chamber; therefore her Husband who knew there was no speaking to her without Precaution, got him a Servant, whose main business was to beat the Drumb, as often as he had a mind to speak to his Wife. As soon as ever they left off beating the Drumb, she heard nothing, but was quite deaf. The second Instance is of one who always stood near the Steeple, that he might hear those the better, who had any business with him. The third of a young Gentleman who was born deaf; when he had a mind to speak with any one, or hear any who had Business with him, he ordered his Servants to beat the Drumb; and as soon as ever the Drumb was no longer beaten, he could not hear any thing, though bawled in his Ears. The last Instance is of a certain Man of Learning, who never heard any thing, unless it was, when he was in a Coach, on a full Career. We have also in *France* a certain ingenious Lady who never hears any one unless it be in her Closet, or in a Coach, when the Glass is shut.

Thus these *Phænomena's* are explain'd. The Deafness of these foremention'd Persons proceeded purely from the relaxation of the Drumb skin, so that without making some great noise, there was no giving the Air that Agitation which was necessary for communicating to the Membrane, that just degree of Tension, which it naturally hath, when one hears well. And if a Drumb was necessary for one, a Bell for another, and the noise of a Coach for a third; that was because the Skin of the Drumb in those Persons we mention'd, was not capable of the same Vibrations; for we must not imagine, that it was the noise alone which made them hear, but it was some particular noise which was proportion'd more to the Ear of one than another.

Mr. Rohault
in his Phys.
Tom.

An able Naturalist hath an Observation which confirms what we have here said, he relateth what he has experienced, that during the last Wars of *Paris*, the

Windows of a certain House shaken, as often they beat a certain Drumb, and that the same Windows did not shake at the beating of other Drumbs, or made a greater noise.

There are some Modern Authors who assert, that *Mr. Perle* Membrane of the Drumb is either stretch'd or *rault Phys.* loosen'd by the Muscles of the Hammer, in order to *Essays* accommodate it self to the diversity of Sounds, ac- *Tom. 2.*

ording as they are more or less acute. They will say it, that it groweth stiffer, is extended when the Sounds are acute, because in that state it is more capable of receiving those nimble Vibrations; and that on the other side when the Sounds are grave, it is loosen'd or relax'd, because in the state of Relaxation, it is better dispos'd to receive those more gentle or slower Agitations: And that in fine, it stretch, and falls a Thousand ways according to the different Idea's of Noises, and different Sounds. Now thus it is.

When the Membrane of the Drumb is extended, both the Muscles are in motion at once, but when it is relax'd or loosen'd, the motion of one Muscle is enough, which is the outward one. All these motions are not any ways regulated by the Will, but they depend purely on the difference of Sounds. Tho' we allow the Use which some ascribe to those Muscles, we must yet observe, that this is rather a voluntary motion, than a pure mechanical one; for tho' the Membrane of the Drumb is extended by the Muscles of the Hammer, yet this happeneth only on the occasion of some extraordinary Sounds, as when they are either too grave or too acute. For the better clearing of this point, let us suppose, the Ear affected all on a sudden with a very acute Sound, the Membrane of the Drumb would thereupon be something loosen'd, in order to moderate the violence of that Sound, and on the occasion of Sounds that should be more grave, the same Membrane would also be a little extended, for the better receiving the impression of the said Sound.

It is evident then, that the Membrane of the Drumb is neither extended or loosen'd by the Muscles of the Hammer, except on two occasions; as for Example, when the sound are either more acute, or
more

more grave than ordinary, it will grow loose in acute tone, and will be extended in a grave one. For to imagine that it is loosened or relaxed, when those Shiverings or Vibrations of the sound are and gentle, or that it is extended when they are quicker or more vigorous: This is inconsistent with the common Rules of *Mechanism*, and even contrary to daily Experience: For those slow or gentle shiverings or Tremblings cannot be effected on a String or Cord, which is loose and unbent, which would rather destroy than receive them; and as to experience they absolutely contradict it, by pretending the Membrane of the Drumb, when it is loosen'd or relaxed, doth better accommodate it self to Grave Tones than to Acute ones, since the contrary appeareth from the precedent observations, by which it appears that too great a Relaxation of the Membrane of the Drumb caused a kind of Deafness, that they who were troubled with it could not hear at all, without some Trick or Artifice, as the beating of a Drumb, playing on a Trumpet, &c. to the end that the means of these extraordinary acute sounds the Membrane of the Drumb might be rendered stiff.

The motion of the Muscles of the Hammer has been said to be voluntary, for we must observe, that they act not at all, when the sounds are moderate, the Membrane of the Drumb being then sufficiently extended of its self, for the receiving of the Impression. But when the sound is extraordinary, that is too acute, or too grave, then the small Muscles of the Hammer are bent, or loosen'd, according as it is necessary for the moderating of the different sounds, and for the better distinguishing of them; and this motion ought to be call'd voluntary, tho' it happeneth without our thinking of it, because it depends on the will one hath to hear well, even as the Contraction and Dilatation of the Apple of the Eye are voluntary motions, because they proceed from the Will or Disposition which one hath to see well.

As for the small Bones of the Ear, which are placed behind the Membrane of the Drumb, they certainly serve to communicate their shivering or motion to

inside of the Drumb, and to the *Labyrinth*:
 The Hammer is first shaken, then the Anvil and
 the Piston, and at last the *Labyrinth*. If they say that
 the Bones are too small to have force enough to
 shake the *Labyrinth*; they do not reflect that very
 small Agitations of the Air are sufficient to form a
 Sound, which these small Bones are capable of re-
 ceiving, by reason of their *Articulation*, and their
 being fastned to the handle of the Hammer, with the
 Membrane of the Drumb; Besides, they being dry,
 and slender, they are very capable of a Spring,
 and very fit to receive the shiverings of the Mem-
 brane, in order to Communicate them to the *Laby-
 rinth*: Thus we see that it is not so much the Air of
 the Drumb which shaketh the *Labyrinth*, as those
 little Bones which are behind the Membrane.
 We may look on these little Bones, in a manner, as
 many little Bells, which Nature hath plac'd be-
 hind the Membrane of the Drumb, to the end, that
 those Agitations which the said Membrane receiveth
 from the outward Air, these little Bells may make a
 Noise within the Drumb.

The Antients imagin'd that the Air of the Drumb
 was an implanted Air, which continued the same all
 their Life time, and that by the means of this, Sounds
 were Communicated: Others have since asserted,
 that the Air of the Drumb was innate or born with
 them; but seeing that it must needs be daily dissipa-
 ted, they have added, that it was renew'd by the
 outward Air which passeth thro' a hole, which opens
 from the Palate of the Mouth into the Drumb, so
 that it could not get out again thence, because they
 thought there was a certain Valve which stopped up
 the Orifice of the *Aqueduct*; but it is more than a
 hundred Years since *Costerus* and *Gasserdus* manifested
 the falsity of this Opinion, because the Air of the
 Drumb doth no way differ from what we Breath;
 besides there is no Valve at the Mouth of the *Aqui-
 duct* for the entrance of the Air, or for the hindring
 it from getting out, when it is once got in, since this
 Conduit or Pipe doth often give Passage to certain
 Corruption or Serofities which are gather'd within the
 Drumb,

It is by the means of this Conduit (as they that a deaf Man may hear the sound of a when he holdeth the handle of it betwixt his Teeth) as also that they who are hard of hearing, may hear well enough when one speaketh to them at the Mouth, because the outward Air being not strong enough to shake the Membrane of the Drumb, it is once loosen'd, communicates its motions to the Air which is within the Drumb, by entering thro' the Conduit of the Palate. By this they give a reason why in gargling one's Mouth, one heareth those who speak to us only after a confus'd manner, because the Liquor which one shaketh up and down in the Mouth, maketh a noise, which is carried by the Aqueduct to the Air within the Drumb, and this noise is the cause why the sounds from without are dead, because the Membrane of the Drumb receiveth but a slight or small Impression of them. We must also add, that the chiefest reason why in gargling one's Mouth, we hear the sound but weakly, is that the noise of the Liquor being Communicated to the Air which is within the Drumb by its vibration, makes the Skin of the Drumb stand outwards, and keepeth it so bent, that the outward Air striking on it, is broken, and looseth its force of sound.

Mr. Per-
rault in
his Treatise
of Noise
or Sound:

It is not only from the Air's passing thro' the Aqueduct that the Deaf hear so much the better, but it is because in holding the handle of the Instrument betwixt their Teeth, the impression or vibration of the Air is presently convey'd from the Jaw-bone to the Bone of the Temples, and to the small Bones of the Ear; That which also savoureth this conjecture is this, that even they who are not Deaf, do hear the sound of a Lute much better when they hold the handle of it betwixt their Teeth, and stop their Ears. One may make the Deaf hear also by speaking to their Head, because by shaking their Cranium, the Impression is communicated to the chief Organ of hearing, and there is a Law in Justinian written, that no one is so Deaf, but that he heareth to some degree. Plempius, in his Principles of Physics, relateth a thing which one can hardly believe, that after an Ulcer in the Ear had eat away the Mem-

Justin.
Law 10.
C. Surdus
Exaudi-
ens,

M

membrane of the Drumb, the hearing remain'd as
 It is true, we have seen the small Bones of
 come away by Suppuration, but this was always
 ded with the loss of hearing.
 The Aqueduct there, where it cometh out of the
 is covered all o'er with a certain Membrane
 inside; and about three Lines distance from
 at the end of it, there are several knobs, like
 notches, where another Pipe or Conduit is
 which is Skinny and Cartilaginous. The
 or finer side of this Conduit is over against
 of the Ear, and the other side of it, which is
 ginous, bends towards the hinder part of the
 This Pipe passeth obliquely from before,
 wards, even to the bottom of the Nose, a little
 the *Uvula*, and about an Inch from that, it end-
 about the middle of the inward part of the *Apophysis*
maxillaris. This Pipe is larger in this place, than it
 when it advanceth more forward, where it is Bony.
 cover'd o'er in the Inside of it with the *Glandulous*
membrane of the Nose, where it opens into the Pa-
 it formeth an edge in the Figure of a *Crescent*,
 so that the lower Horn cometh not within
 Passage of the Nostrils; therefore the Air can
 pass without striking against these Horns, and
 of the Air which is got into this Passage,
 needs enter into the Aqueduct; were it not for
 structure, all the Air of the Nostrils would pass
 the Pipe of the Lungs. As the too great Cold
 outward Air would hurt or prejudice the
 of the inward Ear; so by its passing thro' the
 it is there modified and rendred more tem-
 perate, retaining still its elastick Force, without
 it would not contribute any thing to the
 of the sounds; thus the Air which return-
 from the Lungs, having lost its Spring, passeth
 all into the Aqueduct, because the Orifice of
 which is terminated at the bottom of the Mouth,
 is disposed to give a Passage to the Air which
 cometh in at the Nostrils, than to that which return-
 from the Lungs.

There are yet some, who (with the Antients) *Mr. Peter*
 think that there is an implanted Air in the *Labyrinth*
 because the two Windows which open into the

Cavities of the *Labyrinth* are closely stopp'd up one by the Basis of the Stirrup, the other by the Membrane, so that according to their Opinion the Air of the *Labyrinth* hath no Communication with that of the Drumb.

If the Air of the *Labyrinth* is really innate on us, let them explain to us how it is possible for so small a quantity of Air which continueth in so small a place as the *Labyrinth* is, to yet retain its Spring, during the whole course of one's Life, and yet be qualified to receive the Impressions of the Air of the Drumb: For since there is Transpiration in all the parts of our Body, it is probable, that this small Cavity of the Ear is not without its particular Evaporations also, especially since there is a considerable Arterie and Vein which passeth thro' the *Labyrinth*. All the Vapours of the Blood which at every moment fly away thro' the Pores of these Vessels, must needs fill up this small Cavity, so this pretended innate Air must necessarily lose its Spring; therefore it is impossible it should ever be able to receive those Agitations of the Air, which form sounds; for since the elastick force of the Air, as they suppose, is the only thing that qualifies it for communicating the sounds; it follows, that the Air of the *Labyrinth* is innate or born with us, and hath no communication with the outward Air, and cannot in any manner contribute to our hearing, and we run the risque of being Deaf.

Let us then at present observe, after what manner the sound is convey'd to the *Labyrinth*. If the Air of the Drumb having receiv'd the Impressions of the Membrane of it, presently passeth to the Oval Window, and to the round Window, shaking the Membranes which stop up the Orifice of them. As the round Orifice or hole is stopp'd up with a Skin like that of the Drumb, it immediately receives the Agitations of the Air of the Drumb, which it communicates to the Air which is enclosed in the lower part of the *Testudo*, of the Ear. As to the Oval Window, since it is stopp'd with the basis of the Stirrup, and that this basis is join'd to the Membrane which closeth up the Orifice of this Cavity, it is the shaking of this fine little dry bone, which

communicates the shivering of the Air of the Drumb, the Air of the *Vestibulum*, or *Porch*, the *Testudo*, and the three *Demicircular Pipes*, it is then very probable that the chief Organ of hearing, consists in these Dependencies of the *Labyrinth*, which are the *Testudo*, the *Vestibulum*, and the three *Demi-circular Pipes*, which are so exactly describ'd by *Casseri*, and whose figures are so inimitable.

The *Nervus Auditorius* consists of two Branches, the biggest, which is the uppermost, is called the soft part, the other is called *Portio dura* or the hard part, because it is more Fibrous and more compacted; all the soft Branch is taken up by the Organ of hearing, the two Branches run parallel to each other, for three inches even to the hole of the *Os Petrosum*, and after they are once entred into the hole of the bone of the Temples, the hard part passeth over the other, or upon it; at the lower part of that bottom of a Sack which is at the Hole of the *Os Petrosum*, the soft part is divided into three Branches, the biggest whereof seemeth to terminate on the Basis of the Nut; yet it enters thro' the small holes which pierce it, and is divided into several small Threads or Filaments, which are distributed all over the *Spiral Plate*, just as the small Threads of the *Nervus Olfactorius* pass thro' all the small holes of the *Os Cribrosum*, in order to spread themselves on the Membrane of the Nose.

The two other Branches of the *Portio Mollis*, run thro' the *Vestibulum*, and the *Demi-circular Pipes*, they cover all the sides of them, being dilated or expanded into very fine and delicate Skins. The *Portio Dura* of the *Nervus Auditorius*, after it hath receiv'd a Branch from the *Par Quintum*, passeth thro' a hole which is betwixt the *Apophysis Mastoides* and *Styloides*. It is this Branch of the Fifth Pair, which maketh the string of the Membrane of the Drumb.

The Antients thought it serv'd to form a sound, by communicating its shiverings to this Membrane, even as the string which goeth a-cross the Skin of a common Drumb; but if we consider this string is a true Nerve, we shall easily perceive, that it must have another use, which is to distribute its self to

the Muscles of the small Bones, and to the other parts which are within the Drumb.

Tho' we have already observed, that the principal Organ of Hearing depended on the *Labyrinth*, yet it is not so much the bony Parts, as the nervous Membranes which are spread about them, that are the true Organ of Hearing; for the soft part of the *Nervus Auditorius* receiveth at the same time different Impressions of the Air in three different places. 1st. In the *Vestibulum* or Porch. 2^d. In the Demi-circular Pipes. 3^d. In the *Testudo* or Snail. It is true, that the Sound is more distinct in the Pipes and in the Snail, than it is in the *Vestibulum* or Porch. because these Pipes and the Spiral Plate, which is the chief part of the Snail by reason of its particular structure is better disposed to receive the Vibrations of the Air. As the Plate is hard, dry, fine and brittle, it is very capable of receiving these shiverings of the Air. This Plate is not placed within the Demi-oval Pipe, but it adheres only to the Nut, like the flight of a Stair-case, about which it resteth, almost like a ruff which falleth not on the Shoulder. but is only fasten'd to the Neck, so that the Spiral Plate being thus situated, is easily disposed to receive the agitation of the Air.

Mr. Mar-
riotte.

Perrault.

There are some Moderns, who pretend that the *Vestibulum* or Porch, and the three Demi circular Pipes make no part at all of the immediate Organ of Hearing, and that they serve only to multiply the Impressions of the Tremblings of the Air, which after an infinity of reflections in these winding passages cometh at last to the *Testudo* or Snail, which is the principal Organ. Others will have it, that the small Portion of the Auditory Nerve which is distributed to the Membranes, which cover the *Vestibulum*, and the three Demi circular Pipes, serves for nothing but to communicate the influence of the Spirits to these Membranes, which all the other Parts want, and demand for their particular Substance. They add that there is no probability at all, that so small a portion which is distributed to Membranes of that vast extent, should be able to do the Office of the greater Portion of the soft Branch which penetrates into the Nut, and is all distributed to the Spiral Membrane which hath not the tenth part of that Extent, which

Membranes have, to which the small portion distributed.

According to those Authors we must then conceive all the Contrivance Nature hath used in the *Labyrinth* consists in two things. First, to cause that the Air which is enclos'd may be augmented, there where the chief Organ is seated, and that the effect may be diminished and deadned in other places, hindring the Reflexions which might be made in those Parts, which would occasion false Sounds to the hindrance of those which come from without, for which alone the Organ of Hearing is fram'd. The form and structure of the *Labyrinth* is very proper for this effect, for in the inside it is cover'd with a Membrane which is very capable of hindring those Reflexions which might cause a motion in the inward Air, which is very weak. But the structure of the Pipes of the *Labyrinth* is yet more admirable; it consists in this, that the Cavity of the Snail, where the immediate Organ of Hearing is seated, hath no passage out of it; therefore the impulsion of the Air which is enclos'd there, is much stronger than it is in the other Cavity of the same *Labyrinth*, which has several Pipes or Conduits with several Holes in them, so cannot retain, or keep in the Air which they contain; thus its motion is altogether weaken'd, and in a manner spent.

In order to remove these Difficulties, we shall observe that Birds and Fish do yet hear, tho' they have no *Testudo* or Snail at all; they have only three Demi-circular Pipes, and a fourth, which is perpendicular, which is clos'd at one end, and which opens with the rest into a common Cavity, which one may call the *Vestibulum*. It is true then, that these *Tubes* or Pipes in Fish and Fowl are the true Organ of Hearing. Now why should not these Parts serve for the same use in Man, since they have the same structure? For there are two Branches of the *Nervous Auditorius*, which enter into the Cavity of the *Vestibulum*, they are divided into small Threads and Membranes which cover the Demi-circular Pipes on the inside: Thus we may conclude that this part of the *Labyrinth* also contribute to Hearing.

But that difference which we must here observe this, That the Impression of the Sound is much stronger, clearer and more distinct in the Snail or *Tes- do*, which is the very end of it, than it is in the *stibulum*, or in the foresaid Pipes, because the Membrane of the Spirale Plate is more nervous, and consequently more sensible, besides the structure of the Plate is capable of receiving greater agitations shakings, because being expos'd to the Air, it is the same time affected above and below, which may also encrease its Vibrations. But this Plate is not only capable of receiving the Tremblings of the Air, but it is also capable of having different Tones, like the Strings of Musical Instruments. This Stair-case (as I may so call it) is broad at first, then it grows still narrower, even to the point of the Nut, so that the largest steps of it, which begin at the *Basis* of the Stair, may be shaken, and the other remain unmov'd at the same time, and of these shakings the grave Tones are form'd, and the narrower step of the flight of this Stair-case, producing more nimble and quick Vibrations, do therefore form the acute Sounds to the Touch.

As one of the Branches of the *Par Quintum* hath Communication with the *Nervus Auditorius*, and that this *Par Quintum* is distributed to several other Parts, as to the Tongue, and to the Organ of Speech. We have been willing to explain several *Phænomena's* of this Communication, why, for Example, there is such a Simpathy betwixt Hearing and Speaking; why, Men and Birds excite each other to sing; in short, why those who are born deaf, are also necessarily dumb?

Laurentius. It hath been asserted a long time, before the Moderns, that the only reason why such as were born deaf, were also mute, was this, *viz.* from the Communication of the Nerves of Hearing, with those of the Tongue; but to shew you, that it is not always the Indisposition of the Nerves of the Ear, which is the cause why such as are born deaf are also mute, we shall produce here a very particular Instance which sheweth the contrary. A certain Man who was born deaf and dumb, yet learned at last by great pains and some artificial Helps to speak. It was

Sir Ke-nelm Digby's Hist. of London.

Gentleman who was so deaf, that he could not hear a Cannon, tho' discharg'd at his Ear. Yet in his Misfortunes he was so happy as to learn to speak, by the Pains and Ingenuity of one of his Friends; it was a Church-man, who had been his Tutor. This Gentleman pronounced the Words so distinctly, that they were astonish'd to hear him, yet he remained still deaf, and he had no way to comprehend the discourse of other, but by observing the motion of their Lips: He could continue a long time in Company, without losing any thing of the Conversation, answering particularly to any thing that was said to him. Ah! What Pains, what Contrivance, and Patience, were there necessary to teach this young Man to speak! And as the Master on one side admitted nothing for the Instruction of his Scholar, we may say on the other side, that the Disciple had much Wit, and was very docible to learn to speak, by such new means, as were very difficult to put in practice.

This admirable Instance then sheweth the Falshood of this ancient Opinion of the Schools, by which they pretend to explain, why such as are born deaf, are also mute: They said it proceeded from the Communication of the fifth Pair, with the *Nervus Auditorius*. But they should have observ'd, that it is rather the *Portio Dura*, than the *Portio Mollis*, which hath this foremention'd Communication. It is well known, that the *Nervus Auditorius* is divided into two Branches, one whereof is soft, and the other hard; but it is certain, that it is the soft Part, which is distributed into the inward Ear, and serveth for the Sensation of Hearing: As for the *Portio Dura*, after it is got out of the Ear thro' the Hole which is betwixt the *Apophyses*, *Mastoides* and *Styloides*, it is divided into several Branches which are distributed to the outward Ear. One of these Branches is really joined to a Branch of the *Par Quintum*, but this Communication inferreth no Communication betwixt the Tongue and the Ear, since the soft Branch cometh not out of the Ear, and is no ways joined to the Branch of the fifth pair; so if whatever Indisposition may happen to the *Nervus Auditorius*, that is to say, to the soft Part of it, since this Branch only (con-

tributes to Hearing) it is certain, that the Tongue can be no ways incommoded thereby.

Here's a Problem to be resolv'd, some are apt to ask why the Fire of the Cannon is seen, before the noise is heard? Which one may easily answer by repeating what we have already said, viz. That the Sound is only caus'd by a Trembling of the Air which is carried on successively; so that the said Vibrations of the Air are still stronger near the Bomb which soundeth, than when they are at a distance from it, because the Sound is not extended all about at once, but by degrees: Thus we find that if a Cannon is discharg'd a League off from us, we presently see the Flame, and hear the Sound afterwards, because the Action of Light is perform'd in an Instant, the little Globular Parts which transmit this Action being contiguous to each other, without any space betwixt them, and being incapable of being press'd together. Thus when the Particles of the Flame push those of the second Element, this effort or impression passeth in an Instant from the first Bomb to the last, which toucheth on the bottom of the Ear. In short we may say, that the reason why the Eye perceiveth the Light, sooner than the Ear doth the Sound, proceedeth from the diversity of the Organs. In effect there being several windings in the Ear, a Sound requireth some time to run thro' them, and to arrive at, or reach the chief Organ of Hearing. It is not so with Light, it finds no Obstacle to the Eye, nor windings to move thro', but its course is directly strait forward from the Cornea even to the Retina, thus if any space of time were necessary to make it be perceived, as some Modern Philosophers would have it, it would yet sooner reach the Retina than the Sound would reach the Labyrinth, because of the several crook'd windings it must pass thro' before it can reach that place.

As to an Eccho, all unanimously agree, that it is a *Phænomenon* belonging to the Sound; therefore it is reasonable we should say something of it, before we finish this Subject. The Eccho then is a reflected Sound, which is extended round on all sides, as from the Centre of a Sphere to the Circumference of it, so that the Particles of the Air which would have gone farthe

er, by meeting with some hard Body which they
 shake, they must needs be reflected in some
 to the opposite side, by communicating their
 to those Parts of which they first receiv'd it,
 on successively, which must needs create a
 agitation of the Air in the very place where it
 began, and where perhaps it had for some time
 so that one may hear the second time, the
 Sound which one heard at first ; In fine, it is this
 and thus repeated, which is called Eccho.

To go on with a more particular explication of
 this, one may say this, that if there were several
 at such and such distances, capable of reflecting
 Sound ; it is well known, that the Sound re-
 flected from the greatest distance, when the impressi-
 on of the other Sound was entirely spent, would also
 reach the Ear, and produce a new Sound ; thus it
 appeareth, that there may be Eccho's so dispos'd by
 nature, as to repeat the same words several times one
 after another. In short, some imagine, that there is
 a secret in Architecture to form Eccho's ; for it is ob-
 vious, that the ancient Architects, when they pitch'd
 on any piece of Ground to erect their Theatres
 reserv'd certain places, where they took care to
 place certain brass Vessels of such and such Tones, for
 the forming of an Eccho, which might reinforce or in-
 crease the Voice of those Actors who represented Co-
 medies. In these days also they build certain vaulted
 chambers, wherein the Voice of a Person who sing-
 alone, is repeated twenty four times and more,
 according as the Architect hath dispos'd the Vault, so
 that one Violin or it self in these Ecchoing Cham-
 bers, will produce an agreeable Consort.

C H A P. IX.

Of the Sense of Seeing or Sight.

OF all the outward Senses, there is nothing no maineth to be explain'd but Vision; it is we should have given the Preference in our Treatise to this, since it is the most universal, and most of all the Senses. In effect, nothing hath more activity, nor a larger Extent than the Eye, whether we consider the distance thro' which it perceiveth most remote Objects, or whether we reflect particularly on the use of it, which is so necessary to the Conduct of our Life. In fine, it is by means of the Sight that we behold every thing that is in the world, and on the Earth.

To say something here in particular of the Sense of Seeing, we must confess, that of all the Organs of the Senses, there is none whose Object is more universal, or of a larger extent, since the Objects of Sight are form'd purely by the Light. Now under the notion of Light, we must also comprehend Colours, for Colours are nothing else but Light variously diffracted, that is to say reflected or refracted, in transparent Bodies.

But if we will examine the Eye more nicely, and more narrowly view all the Parts of which it is composed, we may soon discover that the structure is so wonderful, that one may very well affirm, that the great Author of Nature hath left us a greater demonstration of his infinite Wisdom in this Organ than he hath in all the others; for how many Muscles, Membranes, Humours, Vessels, Nerves, Glandules are there in the Composition of the Eye. But we shall have a fair occasion of expatiating on the structure of its parts, when we come to treat of the particular use of them.

It was formerly a great Dispute amongst the Philosophers, whether Sight was perform'd by Emission or Reception.

Opinion. Many have pretended, that it was by Emission, that is to say, that certain Beams or Rays of Light proceeded from the Eye which darted them outward, in order to manifest the Objects; But this Opinion is a pure Paradox, for certainly no Light proceedeth from the Eyes, for the illuminating of Objects. And tho' there are certain Animals whose Eyes seem to be full of Light, as Cat's Eyes, yet is no Argument that Vision is wrought by Emission; some would thence infer. Let us explain this.

Those Animals which they say see by Night, have their Eyes all sparkling with light in the dark, or in obscure places (as they pretend.) And as their Eyes have been observ'd to shine, they were easily perswaded that this light came from their Eyes, and so was sent from without, or exteriour. But here is an Experiment which demonstrateth, that Cat's Eyes do not shine in the dark, as it hath been commonly believed. In order to be the more assur'd of this Matter, They put a Cat into a little close Closet, into which no light could enter; they brought a dark Lanthorn into this Closet, they there perceiv'd no Light at all in the Cat's Eyes; but as soon as ever they brought it to the light of the Lanthorn, tho' never so little, by which some light might be convey'd to the Cat's Eyes, in the Corner of the Closet they perceiv'd two lights, which were the Cat's Eyes which shined like two Candles. From this Experiment we conclude, that it is a vulgar Error to say, that the Eyes of Cats and other Animals which see in the dark, do enlighten any dark places.

We shall no longer imagine for the future, that those Animals which distinguish Objects in the Night do see them by means of any natural light which proceedeth from their Eyes, for this power of seeing in the dark, or in obscure places, is deriv'd from a particular structure of the Eyes of certain Animals, which are dispos'd to receive the impression of weak light. For Example, the reason why the Owl seeth his Prey so well in the Night, is because his Eyes have a particular structure quite different from that in the Eyes of other Animals. 1st. The Pupil is so small, so delicate, and so transparent, that

that one may see even to the bottom of his Eye sensibly distinguish the smaller Parts of the
 2d. The Sight or Apple of their Eyes is so big and large, that the light must needs pass into it very thickly, when this Bird is expos'd to any great or clear day. 3d. The Humours of his Eyes are very clear and transparent, and the watery Humour very plentiful. 4th. The Optick Nerve is big enough and the *Retina* is thick enough, but yet very fine and delicate Texture, and so the more dispos'd to receive the impression of the light: 5th. must observe that the *Choroides* which in most Animals is always black, yet in Owls Eyes, and in Eyes of all other Creatures which see by Night, is a fine silver-blue, which shineth like a Mother of Pearl. This is the Mechanism of the Owls Eye.

Let us view this structure once more, and examine the Uses of it. The *Cornea* of the Owl being fine and delicate, and very transparent as the Humours are, light upon it entring into the Eye of this Bird, is much reflected; for all transparent Bodies do all reflect something of light, as the Dioptricks teach us. All the light then which passeth into the Eye of this Animal must needs strongly affect the *Retina*, since all the light which falls into the *Cornea* passes thro' the Humours without being any thing reflected, and maketh a much stronger impression there, than in the Eye of other Animals. Now we see the reason why the Owl cannot bear the day-light; for having his Eyes very clear by the Transparency of the *Cornea* and the Humours, he receiveth so much light on all sides into his Eyes, that there are no shadows to check or deaden the Action of Light, and dazzleth the Bird, and since he cannot endure the force of the Rays of Light, which affects his *Retina* too vigorously, he shunneth the Light, and retireth to the dark, or some obscure places.

The Eye of an Owl may be in some degree compared to a very light Chamber, whose Shash-windows are washed very clean; where, as a small Candle is sufficient to make the Room light, so also a little Light serveth to light the Eyes of this Animal. as soon as the Sun shines directly in the Chamber Windows, the Chamber will be so light, that

ly bear or endure the Light, besides, if the
 of the Chamber are whiten'd, or that there is
 about it, there will be so great a Reflexion
 that we shall see the Objects but imperfect-
 as the Eye of the Owl, which is to be look'd
 Chamber which is too light, must needs be
 the glittering Splendour of the Sun-beams,
 are darted every where into his Eye, which
 (Center themselves at the bottom of the *Cho-*
 which like a polish'd Looking-glass, doth al-
 the Light, by gathering it all o'er the *Reti-*
 The Sight or Apple of the Eye in an Owl let-
 much Light, which violently shaketh the lit-
 reads of the *Retina*, which being, as we have
 rd, very tender and delicate, some great moti-
 needs be consequently rais'd in the Brain on
 occasion, which will make an abundance of Spi-
 now not only into the Muscles, but also into the
 Muscles of the Body, as into those of the Legs,
 obligeth the Animal to shun the Light which
 it.

when this Bird is got into an obscure place,
 the light that is there, is sufficient to make him
 because by passing even to the bottom of the Eye
 out being reflected, and the great Refractions it
 in the Humours, which are very transparent,
 es or centereth it all on the *Retina*, without lo-
 so much as one Beam, to which we must also
 this, that the light which falleth obliquely about
 sides of the bottom of the Eye is not lost or use-
 because the *Choroides* which receiveth it, being
 black, as in other Animals, but rather smooth
 polish'd, like the Mother-Pearl, it is as we may
 y, a kind of burning Mirror or Glass, which re-
 the Light, and sends it back again on the *Re-*
 where, by the impression alone which it there
 eth, the Animal may see very well, without being
 ways hurt or incommoded; on the other side when
 broad day, there entereth so much light into the
 of it, and the *Retina* is so violently shaken, that
 haps some of the Filaments of it may be torn in
 whence we ought not to be surpris'd to see,
 this Creature cannot endure too much, or too
 a Light. Besides the *Cornea* of the Owl is in the
 Fore-

Fore-part very sensible, because this part is *di-
dinous*, and so it may be subject to Conv
when the light striketh strong and vigorous u
In fine, if the Smoak of a Fire can so far dist
Eyes, as to make them weep, why should we
pris'd, that a strong Light is capable to hurt t
of an Owl, since the *Cornea* of it is *Tendino*
as one may so say, all *Nervous* in the transpare
of it.

As for the *Choroides* we must also observe t
Animals which have it (as the Owl hath i
fine silver Blue, have their Eyes all sparklin
Light, when they are in the dark, or obscure
because the *Choroides* reflects back the Light ou
ly, just as by holding a Looking-glass to th
Beams, one may direct them to several places,
ding as one holdeth or bendeth the Glass, and
the Eyes of those who pass by, by flashin
Beams on their Faces. In fine, if the *Chorioi*
Cat is of a fine azure and polish'd Blue, it is
in a Bat, and in all other Night Birds. But
Ox and Horse it is something greenish.

One undeniable Argument of our seeing t
jects by means of the Light which they reflect
be drawn from what happens in the Optick
ber, where the Objects are painted in Mignat
a Cloth that is extended before the little Hol
which the Light enters. Now since this Pictu
ceedeth purely from the Reflexion of the Ra
must believe that it thus happeneth in our Ey
that is to say, that we see the Objects by ve
the Light which they send forth, but as soon
Light hath pass'd thro' the Apple or Sight
Eye, it hath several Refractions in the Humo
that all the Beams which come from one point
Object, are afterwards reunited in the same po
the *Retina*: Thus you see to what the Structur
Eye serveth, not only to be the Source of Lig
to dispose all the Beams which come from the O
to unite themselves on the *Retina* in that m
which is necessary to cause Vision.

Other Arguments might here be alledg'd, to
That Vision is perform'd by Reception, as tha
an Object is light, it may be perceiv'd, tho

place; if on the other side, the Object is in a dark place, we shall not be able to see it at all, tho' we are in a light place, because the Object which receives Light may send some of it to our Eyes, whereas the Object in the dark receiving no Light, cannot communicate any to us, and this is the true reason, why, when we come from a light place, we cannot perceive those Objects which are in the dark.

Whereas the other Organs of the Senses send nothing outwardly on the Objects, but that the Objects do rather act on the Organs, either immediately as in touching or tasting, or mediately as in smelling and hearing, we know no reason why it should be also so in the Sense of Seeing; for since all our Sensations are nothing but our Thoughts occasion'd by the motions which are imprinted on the Organs by the Senses by the Objects, the Objects of Sight cannot be any otherwise perceiv'd, than other Objects. The Oprick Chamber which we mention'd before, doth evidently shew us, that Vision is perform'd by Reflexion: A Man must be a Fool, and void of common Sense, to assert that it is the Cloath which sendeth Light outwardly on the Object, and afterwards this Light imprinteth the Image of the Object on the Cloath. In fine, all Looking-glasses manifest this Truth. For it would be altogether impossible to explain their Properties by the Hypothesis of Visions being perform'd by Emission only, that nothing proceeded from the Object, as why, with a convex Glass, the Objects seem greater and smaller with a concave one? Why a burning Glass magnify the Object, and why it also sometime presents it in the Air? All these wonderful effects could not possibly happen, without the Reflexion of the Light, which is not derived from our Eyes, but cometh from without, and receiveth different Reflexions, according to the Superficies of Bodies.

A Philosopher of great Repute in the Schools, maintains, that the Object must always have a Medium, for the conveying of its impression into the Organ; He saith also, that in every Sensation we receive the Images of Things, without yet receiving anything of the Substance of them, even as Wax receives

ceiveth the impression of a Seal. The Commentors finding this Opinion of their Masters to be something obscure, they were for explaining it, by taking the Word Image in a literal Sense: They form'd themselves certain *Chimera's*, which they call'd, *Intentional Species*, which (as they fancied) danced and down in the Air. They are confident that Object produceth one in the Air which is near and that this produceth a second, which is also something less, and so on till the last which stops at Christalline Humour, in which they say Vision perform'd. There's the fine doctrine of *Intentional Species*? Which according to the Sense of these Authors are form'd after the same manner, as our Image is in a Looking glass; which is down right *Sophistry* since Vision reflected is more difficultly understood than direct Vision, or Vision in a strait Line.

It is an Argument that those *Species* are purely Chimerical, since they suppose them neither corporeal nor incorporeal, but of a middle nature betwixt corporeal and spiritual Substances, which is really ridiculous, since all Things in this World are either Bodies or Spirits; and that which is neither one, the other, is nothing at all. If they say, these *Species* are corporeal, how can they be all entire in the Object, or in the Medium, and all entire in the Part of the Object or Medium? Yea, this is what they pretend. If they say those *Species* are incorporeal, how shall they act on the Organs? How can they represent things which are extended.

There are too many Absurdities in this, nor should we longer amuse our selves with them, and one may say, that the *Thomists*, who first invented these *Chimeras*, would never have entertain'd any such notions had they but understood, or improv'd the Principles of Opticks. But these Gentlemen were not cut out for trying of Experiments, they wholly applied themselves to *Logick*, *Metaphysicks*, which they were spoil'd by too great a Superfetation of Scholastick Divisions and Distinctions.

Epicurus. A certain Philosopher, who is more sensible than the rest, supposeth that there is nothing in the whole Mass of Nature, but what is corporeal. He explaineth the Production of Images, not by the *Intentional Species*

Species, but by true corporeal Images, which are separated from all sensible Objects, and carried on successively to the Eye. But in opposition to the Followers of *Epicurus*, we say and maintain, that in Vision, there is nothing separated from the Object, since the Image which is painted on the *Retina*, is nothing but Light reflected, which is as we may so say, moulded and imprinted on the Superficies of several Bodies, from whence it receiveth its Figure and Colour, for there is not so much as one point in the Object, which sendeth not a Pyramid of Rays to the bottom of the Eye, and all these are reunited in so many points on the *Retina*, as there are in the Object; thus the Image must needs be painted on this Membrane. So it is in the dark Chamber, and also in the Artificial Eye.

The Knowledge we have of all the parts of a Perspective Glass, hath given us a perfect Idea of the Organ of Sight: The Humours in the Eye serve for the same thing, as the Glass of the Perspective do. The Pipe which is black within side, is instead of the *Choroides*, which is a black Membrane, which renders the Reflexions which otherwise would happen in the Eye. The Partition with a Hole in it, that is less than the Pipe, hath the same effect, as the Rimb or Circumference of the *Choroides*, which formeth the Sight, or Apple of the Eye. The *Ligamentum Ciliare* which supports the *ChrySTALLIN*, is as the Ring or Frame, which holdeth the Glass. In fine, the shortning or lengthening of the Perspective, according to the different distance of those things we should see, is nothing but an Imitation of those changes which happen in the Eye, which can lengthen or contract it self by the motion of the Muscles, so that the *ChrySTALLIN* approacheth the *Retina* more or less, in order to obtain that just distance which is necessary for the centring of the Light on the Superficies of the *Retina*.

Besides, there is an Artificial Eye, which was made some Years since, which perfectly represents the natural Eye. It is a little Globe of Past-board, which is black within side; the *Retina* is form'd of very fine white Vellum, or of a certain flat Glass, that hath been much rubbed with Sand to render it opaque.

Before the Orifice or opening of this Globe, there is a certain Glass which supplieth the defect of the *Cornea*; and instead of the *ChrySTALLIN* Humour, there is a *Vitrum Lenticulare*, which is some small matter thinner than the Humour, because there is nothing but Air in this Machine, instead of the watery and glassy Humours, therefore a small Convexity is sufficient to make sensible Refractions. The *Parchment* or Glass, which is instead of the *Retina*, is fix'd on a Pipe, which one may draw forwards or backwards as one pleaseth. This Machine being placed in a Window, before any Objects which are very clear, one may see them painted on the *Retina* in all their Colours and just Proportions. So it is with our Eye when we look on any Object, the Rays which reflect from it fall on the *Cornea*, in order to pass thro' the Apple of the Eye; in passing thro' the Humours they are broke, and all those Rays which are derived from one and the same point of the Object are reunited again on the same point of the *Retina*.

Of all the Rays which fall on the Eye, there is but one only which enters there in a Perpendicular Line, and that goeth strait on, without turning any thing aside, even to the bottom of the *Retina*. For the rest as they fall obliquely, they are broke in passing thro' the Humours. These Refractions are so necessary, that if it were not so, all the Rays which proceed from one Point of the Object would not be reunited on the *Retina*, but would cover all the bottom of the Eye; to correct, or rather to prevent this Defect, Nature hath placed certain Humours in the Eye of a different Consistency; and the *Cornea*, for the better receiving of the Rays, cometh out a little from the Globe or Orb. This Membrane is not only of a convex Figure, but it is also transparent; to the end, that those Rays which turn too much aside may be the better modify'd, and brought into a just compass; so that in approaching the perpendicular Rays, as soon as ever they pass from the Air into the *Cornea*, this first Refraction rectifieth them, by directing them towards the Orifice of the Apple of the Eye, where as soon as they are entered, they meet with the watery Humour, which redresseth them

Fluidity, and breaketh them, by dividing them
 the perpendicular Ray. The *Chryſtallin* Hu-
 mour which is behind, brings them near to the *Axis* ;
 that by the means of this new Refraction, and that
 which they meet with again in the Glasſy Humour,
 they are dispos'd to be reunited in the *Retina*, in as
 many Points as there are in the Object. from whence
 the Rays proceed ; thus we may ſay that every
 point of the Object acteth on the ſame Point in the
Retina, and ſo every point of the *Retina* receiveth
 an Impreſſion from one only point of the Object.
 It was not enough that the *Cornea* was of a convex
 Figure, or that there were Humours for the Re-
 fraction of the Rays, but it was neceſſary that the
 Eye ſhould change its Figure, in order to accommo-
 date it ſelf the better to the diſtance of the Objects :
 Nature hath alſo been very provident in this caſe,
 rendering the Eye ſometimes long, and ſometimes
 ſhort, ſo that the *Chryſtallin* doth more or leſs approach
 to the *Retina*, according as it is neceſſary for the
 ſeeing the Objects, which are at a greater or
 leſs diſtance.

Now this change which happeneth to the Figure
 of the Eye, is variously explain'd. Some are of Op-
 inion, that it is lengthen'd by the Action of the four
 ſtrait Muſcles, which being contracted, preſs on the
 ſides of the Eye, and then the diſtance betwixt the
Chryſtalline Humour and the *Retina* groweth ſome-
 what bigger. Others aſcribe this lengthening of the
 Eye to the Action of the two oblique Muſcles which
 ſwell the Eye when they are ſwell'd. They ſay that
 the four ſtrait Muſcles, as they act together, do ren-
 der the Eye flat, by drawing it to the bottom of the
 Orbit, and thus the *Retina* is near enough to the *Chryſtalline*
 Humour, for the containing or reuniting of
 the Rays which proceed from any remote Object.
 It is impoſſible that this Swelling, which by ſome
 is ſuppoſed to be in the Muſcles for the rendring of
 the ſides of the Eye flat, ſhould any ways effect it ;
 that may happen on this caſe is this, that the
 ſtrait Muſcles by being contracted, may bring the
 ſtable part of the Eye toward the bottom of it,
 that is to ſay, that part to which the Tendons are fa-
 ſten'd, which is the fore part of the Eye. But for

the sides of the Eye, they cannot be any ways flattened by the swelling of the Muscles; because that is not any thing considerable, in respect of the Contraction, which is the only thing that may change the figure of the Eye, and not by the swelling of the Belly of the Muscles. As to the oblique Muscles there is yet a greater difficulty, the great oblique Muscles being deriv'd from the same Origen, as the straight ones are; and the small oblique Muscle proceeding from a small Cavity or bending in, which in the lower part of the Orbe, thus it is impossible that the sides of the Eye should be any thing pressed together by the swelling of these Muscles. Besides if we reflect a little on the firmness of the Eye, the figure of it, which is almost round, we plainly see, that two such small strings, as the oblique Muscles are, are altogether incapable of an action which is ascribed to them, that is to lengthen the Eye, by pressing on the sides of it.

The most probable Conjecture as to the motion of the Eye and its Humours, when all the Muscles act together is this: This action must needs press all the Eye together except the *Cornea*, because the flat Tendons of the four straight Muscles are fast to the Edge of the *Cornea*. Now as this compression is in a manner equal, no change would thence open to the inward Parts of the Eye, were there some void space under the *Cornea* for the Watery Humour to retire to; but the Eye making no resistance in the Fore part, because the *Cornea* is not any way affected by the Tendons of the straight Muscles, the Eye must needs be equally press'd together by all the Muscles, thus the bulk of it growing less, the Watery Humour is squeez'd out, and driven into the foremention'd void space, upon this the *Cornea* becometh of a more Convex Figure, which cannot happen but that the *ChrySTALLIN* Humour must approach the sight of the Eye, and bring along with it the *Vitreous* Humour, since these two Humours adhere close to each other. Should the *ChrySTALLIN* Humour approach the Apple of the Eye, without the *Vitreous* Humour, the Membrane which holdeth these Humours would certainly break, or be torn in pieces; and as we receive the space which would remain betwixt

ould certainly be filled up with some other Liquor
 of a different Nature than those two other Humours;
 as the Fluidity of this new Liquor would create a
 Refraction in the Rays which come from the
Chrystalline Humour, which would keep them at a di-
 stance from the Perpendicular Rays, by which the
 Vision of Seeing would certainly be rendred confus'd.
 As to the *Vitreous* or Glassy Humour, in respect that
 it is softer than the *Chrystalline* one, it must needs grow
 thick, where it is squeez'd together by the Muscles,
 as the *Chrystalline* Humour by losing something of
 its thickness, comes nearer to the *Retina*.

The *Ciliarie Fibres*, or the *Fibres* of the Eye-lids
 which encompass the *Chrystalline* Humour, are to be
 look'd on as so many small Muscles which being con-
 tracted, do change the Figure of the *Chrystalline* Hu-
 mour, so that instead of an elliptick Figure which it
 had before, it obtaineth a Figure something more
 round, but the *Chrystalline* Humour doth not conti-
 nue long in this Figure, for as soon as the foresaid
Fibres are any thing relax'd again, it recovers its for-
 mer Figure, by vertue of its own Spring. You must
 observe, that the *Ligamentum Ciliare* is the Producti-
 on of the *Choroides*, which is also a true Muscle, as
 the Moderns have demonstrated it. This Ligament
 cannot act, without dilating at the same time the
 Sple of the Eye in some degree, that is to say, the
 largest Orifice or Hole of it is always accommodated,
 and proportion'd to the change which happens in the
 Figure of the *Chrystalline* Humour, which is perform'd,
 as we said before, by the Contraction of the *Ciliary*
Fibres, which equally press it together in all its Cir-
 cumference. Thus you see what change the Parts of
 the Eye do undergo, for the more distinct reuniting of
 those Rays, without any confusion on the *Retina*,
 which proceed from an Object that is at any conside-
 rable distance.

Some are of Opinion, that the Apple of the Eye *Mr. Per-*
 groweth narrow by the contraction of the *Ligamentum rault Eff.*
Ciliare, but that cannot be: First, Because the *Ciliary* *1. Phy.*
Fibres when they are contracted, change the Figure *Tom. 4.*
 of the *Chrystalline* Humour, and render it more round,
 for the better uniting of those Rays which come from
 any distant Object, on the *Retina*. If the *Pupilla*,

or Sight of the Eye should grow more narrow, the smallest Light that should enter there would affect the *Retina* enough to cause a distinct Vision. The Aperture of the Eye then is so far from being made more narrow, by the *Chrystallin* Humours becoming more round, that on the contrary, it is rather dilated for the receiving of the Rays in a greater plenty. Secondly, all the Muscles swell only in the middle betwixt the two Extremities, so that the *Choroides* and *Ligamentum Ciliare* cannot be contracted, but the Edge of the *Uvea* will also be contracted at the same time, which will widen or dilate the *Prunella* or Eye Sight.

The nearer and clearer the Object is, the looser the Muscles of the Eye, as are also the *Uvea*, and the *Choroides*; thus all the Parts of the Eye do reassume their first Figure and Situation; the Eye-lids do something shut, in order to shadow the Eye, and preserve it against the inconvenience of too great Light. It is certain then that the Figure of the Eye is never changed, but upon the occasion of seeing Objects which are at some considerable distance, the Eye hath no need of fatiguing it self to see the things which are at a common distance, this we find by Experience, no one as yet hath explain'd the changes which do happen to the inward Parts of the Eye, we are surpris'd that no one hath said any thing on this Subject, since it may be easily explain'd by Mechanism.

The Rays or Beams which proceed from any Object, crossing each other as they pass thro' the *Chrystallin* humour, it thence happeneth, that the Beam which cometh from above, striketh on the lower part of the *Retina*, and the Ray that cometh from below striketh on the upper part of the *Retina*. The Rays which proceed from the right part of the Object do touch on the left part of the *Retina*; and the Rays which come from the left part of the Object, are directed to the right part of the *Retina*; whence it is, that the Image is turn'd upside down, this is plainly seen in the *Camera Obscura*, the Artificial Eye, and in the *Microscope*.

We have been always much puzzel'd to know whence it cometh to pass, that notwithstanding what

been said before, the Objects appear still in their natural situation: Some say, that the Image which was misplac'd or turn'd upside down on the *Retina*, is again rectified by the *Chrystallin* humour, which, as they say, serveth as a spotted Glass, or *Lenticulare*, to Correct what was amiss in the Image. Another Author hath maintain'd, that the Image was redress'd by the Glassie humour; and *Empiricus* will have it, that it is redressed by the *Concave* Convexity of the *Chrystallin*; yet, by Experience, we find the contrary, if we observe what happens at the bottom of the Eye of a Calf, or an newly kill'd; for having so dexterously cut off the *Membranes*, which covereth the back part of the *Retina*, where the Optick Nerve entereth, that it may be view'd entire, and not any ways torn; if one place this Eye on the side of the *Cornea*, against the side of a Window, and that the hinder part be covered with Paper, or with an Egg shell, we shall have the satisfaction of seeing a kind of a Picture, in which, by way of Perspective, all the Objects from without will be presented to us; but the main defect which will appear in it, is this, that the Picture will be upside down, as we said before, that it was so in the Artificial Eye.

Let one take what Care or Precaution imaginable, it is hard to try this Experiment, for let us do what we please, the *Retina* is always tore, and the watry humour floweth away; yet we confess, that we have succeeded once in this point, but the Image appear'd only after a confus'd manner, and all the parts of the Objects could not be perceiv'd, tho' it plainly appear'd, that they were turn'd upside down.

Tho' it is most certainly true, that the Image on the *Retina* is always turn'd upside down, there are some who maintain the contrary, and who will have it to be right; but this contradicts the very Principles of Opticks. Others again maintain, that the Image on the *Retina* is sometimes strait, and sometimes turn'd upside down, according to the different distance of the Objects. This their Opinion is grounded on this, that by looking thro' a round magnifying Glass, the Object appeareth strait, or upside down, according as the Glass doth

Lewis,
Lauren-
tius Phys.
of Bolog-
na in his
discourse of
the way of
redressing
the Images
in the dark
Chamber.

more or less Approach the Eye. It is really they say, but there is no such thing when one vieweth the Objects without a *Convex* Glass. For they seem always strait, and never turned upside down at what distance soever one placeth one's self to them.

This *Phenomenon* is otherwise explain'd by many, and without any respect to the Eye, they maintain that if the Image which is turn'd upside down on the *Retina*, doth yet represent the Object in its natural figure or Situation, this is an effect of the Sensation of he who seeth. Thus they explain themselves, as the Soul representeth the Sensations of Sight in strait Lines, according to which Sense she receiveth the Impression of each part of the Object; we must needs see it in its true natural situation, tho' the Image thereof be altogether contrary, because the Impression which is form'd in the lower part of the bottom of the Eye, coming from the highest of these Lines, which give Sensation of the Object, it is in this Line, that the Sensation which resulteth from it, is convey'd; so the Sensation that Impression which is made on the upper part of the bottom of the Eye, is referred to the lower part of the Object; and tho' the Image be turn'd upside down on the *Retina*, yet if one looketh on the Object thro' a uniform *Medium*, it may be seen in its true Situation, that is to say, that the Spiritual Image sheweth the Object as it is, thus saith Mr. *Des Cartes* and his Followers:

But methinks this *Hypothesis* doth not resolve the difficulty; for if it be true, as the Philosophers maintain, that the Situation of the Object hath no dependence at all on the Image which is painted on the *Retina*, but is wholly deriv'd from the Soul its self, which applieth its attention to those strait Lines which come from all the points of the Object, how cometh it to pass, that several Persons who are well, and whose Imagination is no ways depriv'd, do yet see the Objects turn'd upside down? *Sennertus* related a particular Example of this, he saith, that a certain Physician of *Dort*, having cast his Eye upward, and taken down a Book in his Library, with great surprise perceived he saw the Objects turn'd upside down.

having afterwards made some motion of his Eyes, having turn'd them, and lifting them upward with some Impetuosity as at first, his Sight was immediately establish'd or rectified as it was at

This curious Observation sheweth us, That if the Objects seem turn'd upside down, it is a pure effect of the change in the Eye, and not in the Sensation of the Person that seeth. Thus when we see the Objects in their natural State as they are, it is rather the effect of the Eye, than of the Soul; or to speak more clearly, it is the natural disposition of all the parts of the Eye in the order they are in, to receive the Images of the Objects, which giveth an occasion to the Soul, to see them in their true Situation; but it be how it will, it is a very difficult problem to resolve, which we shall leave to their discussion, who are well skill'd in Opticks.

The light scarce undergoeth any change, by passing thro' the Glassie or Vitreous humour, yet some are of Opinion, that it bringeth the Rays at some distance from the Perpendicular Ray, by turning them something aside, just as the Glass of a Perspective doth. But in this there is a great deal of difference, the Concave Glass in Perspectives is placed at a certain distance from the Convex one, thus the Rays or Beams, which are derived from the same point, are widen'd and turn'd something aside, which must needs render the Object not only bigger, but also more distinct: On the contrary, the Vitreous humour being join'd to the *Chrystallin*, it can no ways separate the Rays; where if they are any thing turn'd aside, it is not so much from its Concavity, on the *Chrystalline* side, but from its being more fluid, and less transparent than the *Chrystallin*, therefore it must needs break the Rays, by keeping them at a distance from the Perpendicular Ray, or Beam; for according to the Rules of *Dioptrick*, the Beams which pass from a Transparent Medium, into another that is less Transparent, are broken by being kept at a distance from the Perpendicular one.

The Glassie humour then hath not really the effect of a Concave Glass but the true use of it is only to strengthen the *Chrystalline* Humour, and to retain it
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in that Situation which is necessary for the reunion of the Rays on the *Retina* without confusion ; for it was necessary, that the *ChrySTALLIN* Humour should be sometimes nearer, and sometimes further of the *Retina*, according to the different distances of Objects, the *Vitreous* Humour is placed behind to retain, and keep it firm and tight, and for the firmer Situation of it, there is a little Cavity, which in the *ChrySTALLIN* Humour is fastened, as in a Figure. The *Retina* is extended behind the *Vitreous* Humour, all the Objects are painted or represented on this Cloath, and on this strain'd Cloath the Image of the Object is perfectly drawn by the Concave of Light in its true Colour and Figure. to shew you more certainly, that it is the *Retina* which is the chief Organ of Vision, let us examine the structure of it ; it takes its Rise or Origen from the Extremities of the optick Nerve, which enters the bottom of the Eye, just as a Flower cometh from the end of its Stalk, it is composed of very fine little Threads which are deriv'd from the Optick Nerve ; they are easily seen in Water, if you hold or wet the Membrane in it, for being more opaque than the Water and the viscous Membrane which they are wrapp'd, which is a kind of Varnish which is spread all over this Net : This gluy matter is lost, by washing the *Retina* in the Water, which seemeth afterwards to be a very fine piece of fine work ; therefore it is called *Retina*, there are some Veins and Arteries in it, which maketh it red.

The Experiments related here, which prove the Objects are painted on the *Retina*, do also prove that this Membrane is the principal Organ of Vision for as we have said, if we take an Ox Eye, that is fresh, and cut off very dextrously, the *Sclerotides*, the *Choroides*, the *Retina* will remain extended on the *Vitreous* Humour ; and if you place this Eye at the Hole of a Window, before any Objects that are in the light, you will have the Satisfaction to see the Objects painted on this Membrane. You may make the same Experiment on the Eye of a white Rabbit and much easier ; because the *Sclerotides* and the *Choroides* are more transparent in white Rabbits, than in

Creatures, so you need not cut any thing, in order to view the painting Mignature of the Objects on the *Retina*.

The first that ever imagin'd, that Vision was not form'd on the *Retina*, was a certain famous Philosopher, of the Royal Academy of Sciences: He pretended that the *Choroides* is the chief Organ of Vision.

Mr. Mariot in his Letter to Mr. Pectet.

He saith that the Optick Nerve is not directly opposed against the Center of the Eye, but that being bending higher, and bending aside towards the Nose, it is impossible that the Picture of those Objects, which we look on in a strait Line, should fall on the

2d. That this Membrane is not fibrous at all, but that it is only a certain Glue, which doth not penetrate at all into the Brain as the *Choroides* doth, which covereth the Optick Nerve on the other side of the Eye, and is extended with it, even to the middle of the Brain. 3d. That the *Retina* is transparent, and receiveth but a small impression of the Light, no more than other diaphanous Bodies, as Air and Water, and on the other side, black and opaque Bodies, such as the *Choroides* is, receive a greater proportion of Light. These are the Reasons which dispos'd Mr. Mariot to look on the *Choroides* as the Organ of Vision.

Let us see what answer a very able Anatomist made to this. It is true, that the Optick Nerve is not inserted in the Center of the Eye, for it enters there obliquely; therefore if the Rays fall on the middle of the Optick Nerve, as they touch not at all on the Extremities of the small Threads of the *Retina*, (because the Filaments are all about at some distance from each other, just in a manner as those *Fibres* which proceed from the Stalk of a Plant, and are extended all round, for the forming of a Flower) the Vision will be imperfect.

Mr. Pectet.

One may imagine that these small Threads of the *Retina* do open, or spread themselves two several ways. First, By conceiving that all those Filaments which are the nearest to the Center of the Optick Nerve, do exactly end at the Circumference of it, being first cover'd it equally, being divided from each other on all sides, none of the Filaments being terminated in the Extent of the Nerve, before they reach

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its Circumference, the other small Threads of Optick Nerve being terminated at a greater distance in all the Extent of the *Retina*, in proportion to distance they have from the Center of the Nerve where they proceed from it; and that thus all the inward *Superficies* of the *Retina* is composed of the ends of all the Filaments, except that of the Nerve, where no Filament or small Thread is terminated. Upon this Conjecture, if with some of the Modern Philosophers, we suppose, that Vision is purely performed by the Light's falling on the Extremity of some of these Filaments; we may be able to give a reason of that Experiment, which sheweth or demonstrates that we lose the sight of the Object, when the Branches which flow from it, fall directly on the middle of the Optick Nerve: For since there are no Filaments or small Threads terminated in the Extent of the middle of this Nerve, even from its Center to its Circumference, it will receive no impression of the Rays, unless on this Circumference; therefore we shall see only that Object, whose Rays or Branches shall fall within the same Circumference.

The other manner of conceiving the blowing out or spreading of the Filaments of the *Retina*, is to imagine that they are all terminated at the Extremities of a Membrane, just as all the small Threads of a Tuft of Silk do, being once separated from each other. The Rays then a Center from whence all the small Threads spread themselves, which makes a small Cavity in the middle of a Tuft of Silk. Thus the Light falls otherwise on the Center, than on the Circumference of the *Retina*; for they fall directly, or in a straight Line on the Circumference, whereas in the deep place about the Center they fall obliquely, which renders the Vision confus'd, especially when the Object is not much in the light, for let a Candle be at four or five steps from one, one may perceive the light of it a little.

The Vessels of the *Retina* which are big enough may very well hinder Vision; because as they have no Communication with the Brain, the impression of the Object can have no passage by them. Thus supposing that the Rays which proceed from an Object do fall on the greater Branches of these Vessels,

in that no Vision will result from the impressi-
 which they shall make there, and the Picture will
 defective, as it happens on white Paper in a dark
 chamber, when there are some spots of Ink on it, or
 considerable Hole in it; for the more blots of Ink
 are, and the greater the Hole is, the more our
 are depriv'd of the Image of the Objects.

is not so with the small Blood Vessels which are
 on the *Retina*, for if any such thing should
 open out there, as it often happens in the bottom of
 Eye, when the Vision is distinct, no confusion of
 Image would thence happen, because the Vessels
 so small, that they are not sensible; thus as oft as
 Light shall fall on the Vessels of the *Retina*, it will
 be absorb'd there, in proportion to the big-
 ness of the Vessels.

To answer the second Difficulty of Mr. Mariott,
 which is, that the *Retina* doth not penetrate into the
 Brain, as the *Choroides* doth, which is wrapped a-
 round the Optick Nerve, on the other side of the Eye,
 reaching with it even to the middle of the Brain: Mr.
 sheweth us the contrary, since the *Retina* is no-
 thing else but the Expansion of the end of the Optick
 Nerve.

The *Choroides* hath no such perfection in it, it is
 but a Production of the *Pia Mater*, and yet is only
 capable of the sense of pain, as also all other Mem-
 branes are, but no ways capable of Vision, which re-
 quireth another kind of impression, than that which
 causeth pain. The Membrane which the *Pia Mater*
 reacheth to the *Choroides*, must needs be transparent, as
 is on the other side of the Eye, on the Optick
 Nerve, it must needs then let the Light pass thro', e-
 ven to the Vessels, which surround it, and cause the
 thickness of the *Choroides* from the Blood which is con-
 tain'd in them.

The Blood-Vessels can no ways contribute any
 thing to Vision, since they proceed not from the Me-
 llous part of the Brain, for they are Branches of
 the Arteries which are called *Carotides*, and of the
 Jugular which cross thro' the *Sclerotides*, and
 pierce the *Retina* in several places, and sow it (as I
 may so say) to the *Choroides*, by rendring it opaque.
 The Net-work of these Vessels do something resemble
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the *Chorion* or *Placenta*, from whence it is called *roides*. Among the Blood Vessels there are also *Filaments* of the *Nervi Motores*, which contribute more to Vision than the said Vessels do, so that can perceive nothing in the *Choroides* to convince that it hath any communication with the Brain on the contrary, the *Retina* is nothing but the pansion of the Optick Nerve.

In fine, to answer the third Difficulty, Mr. *Key* confesseth, that the *Retina* is something transparent, and that one may see thro' it, the colour of *Choroides*, when it is join'd to it; but there is no comparing the Transparency of it with that of the Air or Water, for the Transparency of the *Retina*, in a manner like that of oiled Paper, and less than that of the Horns of a Lanthorn. The whiteness renders it opaque enough to stop the Rays as much as necessary for Vision, which would never be effected distinctly enough on the *Choroides* thro' the *Retina*, for were it necessary that the Images should come even to the *Choroides*, the opakeness of the *Retina* would be as destructive to Vision, as the opakeness of the *Cornea*, or of Humours of the Eye would be, which are therefore transparent, for the better passage of Light even to the *Retina*.

One may easily observe, that the *Retina* is transparent; it is, but hold it in the Water a little, it appeareth all white, and very little transparent.

The blackness of the *Choroides*, which Mr. *Mary* believeth, is so necessary for the perfecting of Vision, is not to be found in the Eyes of all Animals; it is true, that its black in many Eyes, but this blackness is not alike in all, for in some Eyes there is more blackness, in others less. There are Birds and Animals whose *Choroides* is black. But in the Eyes of Lions, Bears, Camels, Oxen, and Sheep, Dogs and Cats, and many other Animals, the bottom of the *Choroides* is often of a colour as clear as that of the Mother-Pearl, and Iris, as we have observ'd.

If you scrape the *Choroides* gently, you take off the colour of it, and we discover a white Substance, which is spread all over this Membrane, so that the Light can

pass even to the back part of the *Choroides*, to that Impression there which is necessary for the acting of Vision; and the blackness of the *Choroides* serves for nothing else, but to hinder the Light passing into the Eye, any other way than by the pupil of it, or the *Prunella*. If the *Choroides* were not of black Curtain extended behind the *Sclerotic*, the light would pass thro' this Membrane, as a piece of Parchment, even to the bottom of the Eye, and so would efface the Images which would be made on the *Retina*.

The Fish have also a *Choroides* very clear and polished, it seems like a dusky Silver, or the Water of the clearest Oriental Pearl. This variety of Colours is to be found in the *Retina* of a Man's Eye, or of other Animals, it always retaineth its transparency and opacity: This maketh us imagine that the *Retina* is better for Vision than the *Choroides* is; for the *Retina* having no other Colour but white, it is thereby better able of receiving all other Colours. It is not so of the *Choroides*, for as that is in most Animals of a dark Colour, the light which is reflected from outward Objects, would make a confus'd mixture, and would also render the Vision confus'd.

Whereas some pretend that those Bodies which are white, do receive a much greater impression of light, than white Bodies, it is to be understood that it is then when the light is immediately receiv'd on the Body, without passing thro' any Medium, that may be its Rays. Black Paper expos'd to the Center of a burning Glass, is burnt as it were in a moment, whereas white Paper on the other side, hardly taketh fire, unless there be some blackness or filth mix'd with it, and if you place black Paper behind the white, the Heat will, by a small impression, soon set it on Fire. But at present we do not treat of this impression of Heat, nor of all the other Impressions of the Sun, but purely and distinctly of Vision, which requireth no Heat, but only a moderate Light which is not so well effected on the *Choroides* as on the *Retina*, (which is a hindrance to the *Choroides*) and which hath nothing before it, when the Humour and the *Cornea* are in their natural situation.

Mr.

Mr. Mariot addeth also, That for the perfect Vision, it is necessary, that the Rays which flow from each point of the Object, be united on the point of the *Retina*, and as it is about half a Line thick, the Beams meet on the Superficies, which to the *Vitreous* Humour, they would go cross each other and fall into different points, on the inward Superficies of the *Retina*, which is united to the *Choroides*, and were the Rays reunited on this last Superficies, the Rays would certainly have pass'd thro' different points of the first Superficies of the *Retina*, which to the *Vitreous* Humour, but if this Reunion of the Rays were betwixt the two Superficies in the thickness of the *Retina*, they would fall on different points on both Superficies, and in all such occasions the Vision would be confus'd, whereas the *Choroides* which is very fine and opake at the same time, may easily receive the Light.

It is true, in order to compleat a Vision, the Rays which flow from every point of the Object to the Eye, must necessarily meet on the same point of the *Retina*; but this is no Mathematical Point, rather a Physical one of a considerable bigness, in the smallest part of the Object, which we see with the help of a Microscope, we still discover many Parts; and one may say that we see then the Object more distinctly there before, tho' we see nothing but in a confus'd manner. Now it is evident, that from every point sendeth Rays on the *Retina*, it will cover every part of this Membrane, in proportion to its bigness, and if it penetrated thro' the *Retina*, it would take all the thickness of it, especially in a Man's Eye, where the *Retina* is not much thicker than a Sheet of Paper, twenty of which would scarce make a Line.

When Mr. Mariotte saith, that the *Retina* is half a Line thick, we must not believe him, for in a Man's Eye the *Retina* at most is but a quarter of a line thick, and is in all other great Animals; thus we do not see the difficulty of Mr. Mariotte is any ways inconsistent with their Opinion, who hold that the *Retina* is the Organ of Vision. Supposing that the *Retina* was as thick as he saith it is, this thickness would only render it so much the whiter, and the more opake, and would

Rays from passing in that quantity to the *Choroides*, which thereby would be the less qualified to be the Organ of Sight.

In fine, they say also that the *Choroides* which is soft and opake, may receive the Rays from the same luminous Point, which might well be, tho' it should be very thick were the *Retina* (which is very opake) a hindrance or Impediment to it ; but we are satisfied that the *Retina* stopperth the Image of the Objects, and hinders it from passing any further.

We shall not dwell any longer on these tedious Difficulties. If the Answers which Mr. *Packet* returneth Mr. *Mariot*, seem obscure, we have done all we could to render them still more Intelligible than they are in his Letter. Having then plainly discover'd, that the *Retina* is the chief Organ of Vision ; we must now examine how the Image of the Object is communicated to the Brain, for without the communication of the Eye with the Brain, there is no Sensation at all, as is evident by Experience in the *Gutta Serena* ; for it is not enough that the Image be printed on the bottom of the Eye, and on the *Retina*, but it must also be conveyed to that part of the Brain, where the Soul may have a perception of it.

As soon as the light acteth on the Eye it presseth, in a manner shakerth up and down the end of the small Threads of the *Retina*, so that this motion being communicated to the Spirits which are contain'd in these Filaments, certain particular shiverings do follow thereupon, which are continued in the Brain, even to that part of the Brain, where the Optic Nerve taketh its Rise, and it is this motion which gives the Soul an occasion of forming the Spiritual Image of the Object ; that is to say, that the Soul has as many particular Sensations as there are varieties in the motions of the Image, which are proportionable to those of the Object.

Thist Vision is thus perform'd, as we have explained by those Animal Spirits which are contain'd in the small Threads of the *Retina*, which pass even to the Brain by certain undulations or shiverings, which they make ; if the Light happen to be too strong, and that the Eye is offended with it, the Vision

sion will be deprav'd, and the Objects will appear but after a confus'd manner, because of the dance of Rays which fall on the *Retina*, which happens may tear in pieces some of the small Threads of it; or else the Spirits are so much agitated, the *Retina* becometh so much extended with it, that it afterwards becometh incapable of being affected with Objects which are less luminous. I may say also, that this Depravation of the Vision proceeds from this, that the Spirits of the *Retina* are driven back again even to the Brain: Thus all the nervous Pipes of this Membrane being empty, grow loose or relax'd, and fall or sink down flat each other, and so grow incapable of communicating the impression of the Object even to the Brain for the Nerves to promote Sensations, must have some Tension, or rather a kind of Spring act on the Spirits.

But when the Spirits have once recover'd their motion, and that they flow as they us'd to do in the small Filaments of the *Retina*, these small Threads do afterwards recover their first Flexibility, and they are capable of communicating the impression of the Image to the Brain.

Some ask why, after one hath look'd stedfastly at the Sun, or any other clear Light, the Impression still continueth afterwards, and tho' the Eyes are now clos'd, we seem to see several colours: This blemish is easily solv'd, by saying that the extraordinary motion which violently shaketh the small Filaments of the *Retina* cannot cease so soon, and this agitation continuing still even after one's Eyes are shut; but being no longer strong enough to present the clear light of the Sun which caused it representeth weaker colours, which still change, this motion groweth weaker, which evidently sheweth, That the Nature of Colours purely consists in the various motions of these small Filaments of the *Retina*.

Here's another very hard Problem, which hath puzzled the learned all along. They would know how it cometh to pass, that the Object which we see with both Eyes doth not appear double, there be an impression of an Image in each

we have pretended to solve this Problem by say-Gassen-
 that we ought not to be surpris'd, that the Ob- dus.

seemeth but one, tho' both the Eyes are open,
 cause we never see the Object distinctly, but with
 Eye. But Experience sheweth us the contra-
 since we see better with two Eyes than with

They who explain Vision by Emission find no diffi-
 ty in this *Phenomenon*, because according to this
Hypothesis, the Rays which at the same time pro-
 ceed from both Eyes, meet on the Object, we shall
 amuse our selves any longer with this Opinion,
 being confuted it in another place.

Galen and after him *Visellion* assert, that Vision
 purely proceedeth from the action of the Objects
 ing to the concurrence of the optick Nerves; This O-
 pinion is confuted by the Experience of the Modern
 anatomists, who have found out, that these Nerves
 do not so concur, as to be united to each other, but
 only that they come near each other, in order each
 of them to continue their course to the Brain. The
 optick Nerves have been always thought to mix
 their substance with each other, by being united in-
 to one String, which was afterwards divided into two
 branches which went to the Eyes, but as we said just
 before, they are two distinct Nerves which are separa-
 ted in all their course, and come near each other above
 the Seat of the *Sphenoides*.

This *Phenomenon* doth not appear any ways diffi-
 cult to *John Baptista Porta*, for he pretends with
Descartes, That we never see but with one Eye, tho'
 both Eyes be open; which is yet contrary to Expe-
 rience, as we have observ'd. Others will have it, that
 there are two Images of the same Object, but
 that the reason why we see but one single Object is
 that our Attention is applied only to this Ob-
 ject, and both Eyes are fix'd on that only. But what
 will they say if we shew them, that the Object, tho'
 it self it be only single, may yet appear double to
 the Eye, when one presseth it after a certain particu-
 lar manner.

To explain this *Phenomenon*, some have conjectured Mr. Ro-
 bert, that besides the Resemblance, or sensible Image hault.
 which is in both Eyes; there is also another Image,
 which

which consists in the number of the small Threads of the *Optick* Nerve, which is equal to the other. For the better clearing of this point, they suppose that one of the *Optick* Nerves is composed of five small Threads, the Extremities whereof may be 1, 2, 3, 4, 5, and that the same number may also be in the other number, whose Extremities are 6, 7, 8, 9, 10. We must also imagine, that the Extremities of those two small Threads, 3 and 8 which are in the middle of the rest, are exactly at the end of the *Optick* Axes that is to say at the Extremities of those Rays which pass thro' the Centers of the Apple of the Eye, and the Humours, and that the end of the other small Threads are so exactly ranged about those in the middle, that one may take separately in order, all the small Threads of one *Optick* Nerve, and compare 'em with those of the other, taken in the same order, make several pairs of them which we shall call *Symphathick*. Thus beginning with the small Threads one and six, which are at the left side of each Eye we have the first pair. The other pairs are 2, 7, 3, 8, 4, 9, and 5, 10. In fine, they say that the *Symphathick* small Threads of each pair do end in the same point of that part of the Brain, which is the Seat of the Soul; from thence it follows, that instead of two Images which the Object painteth in both Eyes, there can be but one form'd in the Brain.

Brigge *Op-*
thalm-
graph.

An able Philosopher of *England* supposeth almost the same thing as Mr. *Robault* doth, but thus he differs from him, he saith that the small Threads of the *Optick* Nerves are continued from the place in the Brain, from whence they have their Rise, even to the *Retina*, and that those *Fibres* have the same Situation in both Nerves, and that they have the same *Parallelism*, and the same degree of Tension, so that the Object cannot touch, on one in one Eye, without touching on the other which is over against it, these two *Fibres* having the same Tension, we shall look on them, as on the Strings of two Musical Instruments which are tuned to the same Unison, thus the Soul will have but one Sensation of the same Object, both Impressions being reunited into one, the disposition of the small Threads of the *Optick* Nerve

nerves, which answer each other exactly, and have the same degree of Tension.

But without offering the least violence to the Reputation of Mr. *Brigg's*, we propose here some doubts, which seem to invalidate the Arguments of this Philosopher. 1st. Supposing that this Harmony of the small Threads of the *Optick Nerves*, which have the same *Parallelism* was the true reason why one seeth the Object single, yet the Sight would be oftner deprav'd than it is, because it is evident that this *Parallelism* cannot continue long in the same state, especially in those Persons, who abound with much *Lympha*, and who are dispos'd to a *Gutta Serena*, because one of the *Fibres* of the *Optick Nerve* may be relaxated by some Humidity, whilst the same small Threads of the other Nerve shall still retain its Tension. 2^d. How cometh it to pass, that in pressing of the Eye, and keeping it in a forced Situation, the Object seemeth doubled; we know very well that Mr. *Briggs* will answer according to his *Hypothesis*. That these Rays fall not in the same *Fibres*, but in contrary small Threads, which have not the same Tension, but when the *Parallelism* of the *Fibres* of the *Optick Nerves* is chang'd, do not the other Parts of the Eye also change their Situation? Thus we may still reasonably doubt, whether the reason of an Objects appearing single, is more to be ascrib'd to the *Parallelism* of the *Optick Nerves*, than to that of all the other Parts of the Eye, for these have their *Parallelism* also, and when it is chang'd, the Object appeareth double. For Example, let us suppose a change in the *Christallin Humour* of the left Eye, viz. that it is either more near, more remote, or more retir'd to the sides than the *Christallin* of the right Eye is, we shall then see double.

The same thing will happen also, if one of the Eyes changeth its situation, and falleth down on the Cheek. *Langius* relateth an Instance which will be proper here, since it sheweth plainly, that the change of the outward parts of the Eye is sufficient sometimes of it self, to make one see double. He saith, That in the wound of an Eye it happen'd, that after it was well cur'd of the wound, it stuck fast to the lower Eye-lid, so that the Eye being forced, and the

Apple of it becoming something lower than that the Eye that was well, the Person saw quite double. This inconvenience lasted as long as the Eye was glued to the Eye-lid, nor was it remov'd till the Eye cover'd its free motion, and that the Eye-lid something loosen'd again by giving way. From thence we must conclude, that the reason why Objects seem double, always proceedeth from the Eyes being displaced, or from some change in some parts of whence the two Eyes being depriv'd of their just *rattelism*, they see not as they did before.

To finish this Chapter more compleatly, we here give you an account of the discovery of the Pipes or Conduits which carry the watery Humour to the Eye. No Anatomists hitherto had any Knowledge of them, the Ancients ascribed all to the Providence of Nature, which (as they imagin'd) still furnish'd the Eye with as much Water as was necessary. Some of the Moderns have maintain'd, that the watery Humour was supplied from the small *Glandules* of the *Sclerotides*: Others, who look'd on this passage not so feasible, have rather deriv'd it from the Nerves; in fine, they have also said that the watery Humour was discharg'd into the Eye by the *Lymphatick Vessels*.

Mr. Nuck The first, who in the explaining of the natural Conditions of Animals, have recourse to the Providence of Nature, are not all to be minded. As to the *Glandules* of the *Sclerotides*, no one as yet, hath seen them, this is only a pure Conjecture. This opinion is much of the same nature, which several Anatomists have had about the Separation of the *Bile* from the little Bladder of the Gall. They would have perform'd by the *Glandule* of the inward Membrane of the said Bladder; but we have shew'd, where we speak of the use of the Liver, that the *Glandules* of the Bladder, serve only to filter a little *Lympha*, as for the *Bile* it is separated by the *Glandules* of the Liver, and convey'd thro' known Conduits into the Gall-Bladder.

As for those who have imagin'd that the watery Humour was only a *Succus Nervosus* convey'd thither by the Nerves, they have been sufficiently confuted where we speak of the use of the Nerves; we have shew'd

that there that nothing floweth from those Nerves which are cut, but a *Lympha*, which cometh from the *Lymphatick* Vessels, which run thro' the Membranes of the Eye.

In fine, if the watery Humour came from the *Lymphatick* Vessels, that would be contrary to the Motion of the *Lympha*, which hath the same motion as the Blood hath in the Veins, that is from the Circumference to the Center, and not from the Center to the Circumference; for the great number of *Valves* which are in the *Lymphatick* Vessels, would hinder the Liquor from passing from the Center to the Circumference.

All disputes about the Source or Rise of this watery Humour should now cease, since the Pipes which carry it to the Eye are sufficiently known. This Discovery, as well as all others in Anatomy, is purely owing to chance. These water Pipes were first thus discover'd in dissecting of a Sea-dog, they discover'd a Pipe which pierc'd the *Sclerotide*, and open'd it self into the *Cornea*, near the apple of the Eye. They put a small Bodkin into this Pipe when they drew it out again, no watery Humour flow'd out of it, because the end of that Conduit was dispos'd after the same manner, as the orifice of the *Biliary* Conduit in the *Duodenum*, or that of the *Ureters* in the Bladder; where they had once taken the Eye from the Orb, they could not make any farther discovery of the Rise of this new Conduit.

This new discovery is certainly of great importance; it hath helped us to give a reason of many disorders in the Eyes, which were never explain'd in that manner, as we have done it in the Pathology of our Surgery which we lately publish'd.

To be the more assur'd of the Existence of these water Pipes, we continually made several Experiments on the Eyes of Animals: We dissected the Eyes of a Sheep, in which we did not only find a Pipe or Conduit, as in the Eye of a Sea-dog, but we also plainly discover'd five others. Another time we found six, which ran thro' the *Sclerotides*, which open'd themselves there, where the *Cornea* beginneth to be transparen-
t. These Pipes were easily known by their red colour; one might easily put into them a Hogs
X 4
Bristle.

Bristle. In Dogs there are but two of these Pipes each Eye; one is under the *Abduſtour* of the Eye and the other is plac'd over againſt it, under the Muscle call'd *Adduſtour*. Theſe Pipes are plainly diſcover'd in a living Dog, you muſt take off this upper Eye-lid, you may perceive them ſtill better in the Dogs which have great large or full Eyes.

Tho' theſe Conduits go on in a right Line on the *Conjunctiva*, without going any thing a ſide, yet ſome of them ſometimes go ſide-ways, and pierce the *Sclerotides*, there where the *Cornea* is transparent, as we have obſerv'd before. Theſe Conduits are not ſo viſible in a Man or in a Calf, as they are in Dogs and Sheep, yet they are plainly ſeen in Men's Eyes. On the *Sclerotides* and the *Cornea* they appear all black but elſewhere they are not of that colour. The dark colour proceedeth from the black Humour of the *Choroides*, it enters in at the oriſice of theſe ſmall Conduits, eſpecially when they are not quite full of the watery Humour. Since they are open where they are black, ſome ſmall quantity of this black Humour may eaſily paſs into them, and ſticking to the ſides of them, it blackens them. Something alſo of this black Tincture may paſs into them by the continual motion of the Eye.

The *Glandules* of theſe Excretory Pipes are not yet diſcover'd, we have only trac'd them for two or three Lines, even to the *Optick Nerve*, to which they are all along join'd. It is impoſſible to determine exactly how much water theſe Pipes furniſh the Eye with in one Day; we ſhould faſten a very ſmall Valve to them, with as ſmall a Neck as thoſe little Glan- dular Pipes which we make uſe of when we look on any Liquors with a Microſcope, but this is an operation not to be done. We can only judge, that even there fall ſome drops of this watery Humour in the room of that which is diſſipated by *Transpiration*. The quantity is more or leſs ſeparated of it, according as the motion of the Blood is more or leſs ſwift, as it happeneth in all other Filtrations. There are no *Valves* in theſe water-Pipes, and they are thicker than the *Lymphatick Veſſels*. It is true, Mr. *Steno* formerly obſerv'd ſome ſmall Pores, which open'd toward the *Sclerotides*, but he doth not ſay, that theſe ſerv'd

any ways for the passage of any Li-
 The use of these Water-Conduits is enough to
 us not apprehend but that the Eye may yet re-
 its natural bigness, even when the watery-hu-
 is flow'd out, as in the case of some Wounds,
 the operation of couching the Cataract; for if
 loofeth the Eye on these occasions sometimes, it
 from the flowing away of the watery-humour,
 from the Apple of the Eye, or the *Prunella's* being
 and the adhering of the Cataract.
 All those Remedies then, which have been so much
 up, for the repairing of the watery-humour, as
Terra, Catechus, Celandine, &c. are altogether use-
 to this Point, and serve only to abate the Infla-
 tion. It is a pure Fable of the Ancients, that the
 Swallows make use of Celandine to recover the sight
 their young ones; for if any Celandine by chance
 been found in any Swallows Nest, we must be-
 lieve that some other Bird hath carry'd it thither, since
 Swallows feed only upon small Flies and Worms
 which they catch.
 In fine, the reparation of the watery-humour was
 unknown to *Galen*, since he saith, that he saw a
 Child who had been wounded in the Eye, whose wa-
 tery-humour after it had flow'd out, was afterwards
 repaired.
 After all these Experiments, we must not be fur-
 ther at that Passage in the *Bizantine* History, where
 we read, that they pricked the Eyes of some *Turkish* Em-
 perors, with a design to deprive them of their Sight,
 yet they presently recovered it, notwithstanding
 the Violence offer'd them.
 As the Analysis of the humours of our Bodies may
 help us to find out some Remedies for the Diseases
 which they cause, so accordingly many Experiments
 have been made in most of the Humours of a Hu-
 man Body: The watery-humour hath been found
 to contain in it an acid Salt, with much Flegm and
 Mucous; for tho' it hath no smell, and that it is com-
 monly insipid as the simple is, it hath been observ'd
 that there is some Volatil Salt in it, since we have
 found it sometimes saltish in Persons that are grown
 up.

up. This watery-humour when its newly taken the Eyes of young Animals is clean and transparent but not so clean as Water; whereas in old Animals it is thick and much troubled. When it is kept it is like the white of an Egg.

We have observed also that the watery-humour of the Eye and Rose-water do not mix together, when they are put over the Fire, then the mixture of them groweth thick and troubled; on the other side the mixture will grow blue if you cast a little of the powder of Vitriol on it. Neither doth Plantine, Fennel Eye-Bright-water mix it self alike with this watery-humour of the Eye; but if you take a little of it the Juice of Celandine and set it over a Sand-fire the mixture presently coagulates and Precipitareth.

Cows Milk and the watery-humour mix perfectly well together, for as soon as ever you put but a little Vitriol to it, there will be a Coagulation; and if you pour some drops of the Spirit of Vitriol on the watery-humour, it presently dissolveth and groweth Liquid. In fine, if you add a little Crocus Metallorum to the mixture will remain always the same without any change.

C H A P. X.

Of the Inward Senses.

WE must conceive that there are two inward Powers or Faculties in Men; the one of which is Material, and that is Reason, the other Material, which is subordinate to the first, and is commonly called *Imagination*; which comprehends also the inward Senses. We shall say nothing here of the Understanding, that being a pure Metaphysical Subject, and not mention'd in a Physical Treatise, which should treat of material things. These matters are really so subtle, and the Organs which the Soul maketh use of for the discharge of her Functions, are even at this time so little understood, that we were about to say nothing at all of them; but to render this Physical Treatise the more compleat, we at last resolv'd to say something of them.

Authors are not agreed among themselves as to the number of the inward Senses; some say there are five, others make them six, and others again but two. Others again to avoid Confusion, will have it that there is but one inward Sense; because, say they, it is all the same Soul to which all those Faculties which we distinguish into several Senses are ascribed. For example, It is the Soul which seeth, which understandeth, which imagineth, and which remembreth. The Soul is only bounded by the different Organs by which she perceiveth all things; thus when we commonly distinguish the inward Senses, and that we make several kinds of them, which are common Sense, Imagination and Memory, by saying that the common Sense is only that Function or Power which the Soul is of perceiving and knowing the image of the outward Senses; and that Imagination is another Faculty by which the Soul knoweth the Objects as they affect the Organs of the Senses by their presence, and can retain Images of them, when they are gone; Memory is that Faculty by which the Soul remembreth.

remembreth the things that are past, yet all these culties are really but one and the same thing, that is to say, it is the Soul, which by working inward hath several different Faculties.

Neither are the Ancients much agreed in the Descriptions which they have left of the inward Senses. Some of them ascribe that to Imagination, which properly belongs to common Sense; others on the contrary ascribe that to common Sense, which belongs to Imagination. But to avoid Equivocation and Confusion we shall say, that the word common Sense may be taken in two ways or manner of speaking. We use this term either in an improper sense, or in a proper sense. To speak improperly, common Sense signifies the same thing as Reason, whence we commonly say he hath not common Sense, when we speak of a dull and stupid Person, who hath not the use of his Reason, that is to say, who want that which other Men commonly enjoy; and to speak Philosophically, common Sense is nothing else but the seat and center where all the outward Sensations meet, that is to say, the place where the Soul perceives and taketh Cognisance of the Impressions which are convey'd to it from the Organs of the Senses; as the Eyes, the Ears, the Nose, the Tongue, and the Hands of Touching.

Common Sense is also called the first Imagination, to distinguish it from the other kind of Imagination, which consists in knowing Objects present and absent. It differs from the outward Senses in this, that the outward Senses have no knowledge of sensible Bodies, as they are in themselves but only as they are represented by the Organs. Whereas common Sense knoweth them under certain Ideas by which it distinguisheth one from the other; that is to say, that common Sense perceiveth the differences which are betwixt the Objects of the outward Senses. For Example, It is common Sense which maketh the difference of all sensible Objects, by distinguishing Smell from Colour, Colour from Sound, and which even distinguisheth the Objects of the sense, as Red from White. But this difference of the common Senses with the outward Senses is purely Accidental, as we have already observed. For to speak properly it is nothing but that chief

Brain where all the Impressions which pass
the Organs of the Senses do meet.

For Imagination, it is that Power by which the
perceiveth things absent or present; so that the
difference betwixt Imagination and common Sense is
that common Sense only distinguisheth the Objects
each other, during the time of their Action,
as Imagination can form an Idea of the things
only when they are present and actually Influ-
ence the Organs; but when they are absent by Ver-
bal Traces or Marks which remain in the Brain.

We may easily perceive by this Definition of Im-
agination that nothing but sensible and corporeal things
are imagined, since those only act on the Organs
of the Senses, and print in the substance of the Brain,
Images which the Soul may make use of wil-
lily, or by the return of the Spirits into the Tracts
of the Nerves, and which shakes the Nerves as the Ob-
ject would do, should they act on the Organs. For
example, when our Soul imagineth an enchanted
Island, the Idea which it forms of it, depends on the
Images which it hath to imagine; but on the other side,
it receiveth this Idea from the course of the
Spirits, which enter again into the prints of the Brain,
and Imagination then is not properly the Action of the
Soul, but a pure Passion.

As to the Memory we commonly say, that
it is that which receiveth the Species of things from
Imagination, to keep and retain them as occa-
sion may require, and to muster them together by ma-
ny ways to return to the Imagination; therefore some
call'd it the Treasure of Corporeal Species so di-
stinguish'd from the Intellectual Memory, which only
keepeth and preserveth the Idea's of things as purely
intelligible, and which fall not within our Imaginati-
on. Others say, that Memory representeth to the
Soul things pass'd, as if they were present, and as they
have been receiv'd by the Organs of the Senses. But
we must observe, that the Ideas of those things which
come into our Memory are not always like those
which come to us by our outward Senses; nay, they
are often very different, as when they proceed from
Imagination, which sometimes acteth without any
aid at all: Whence it cometh to pass, that things
are

are quite otherwise when we remember them, what they were at our first thinking of them.

We allow but of one inward Sense, which have many Functions: For Example, we shall that common Sense is an Action of the Soul which it receiveth the impressions of the Objects which have been convey'd to it by the Nerves, to that place where she may perceive them; and cause this motion of the Nerves, and the Spirits, in the Brain a certain impression which may be retained of it self, that is to say, by the course of the Spirits as often as the Spirits shall return into these Tracts of the Brain, the Soul will remember those things which it formerly thought of, that is to say, that we have Memory: We see then that Memory and Imagination are only the same thing, since Imagination is nothing else but the course of the Spirits through the same Tracts of the Brain.

Having thus establish'd but one common Sense, which is sometimes called Imagination, and sometimes Memory, we may easily determine our Opinion about the seat which is ascribed to these three Faculties; about which Authors do very much differ: for some place the Seat of common Sense in the front part of the Head or Brain, and that of Imagination in the middle of the Brain, and that of Memory in the hinder part of the Head; that is to say, that these three Functions are performed in the Ventricles of the Brain.

But as to those Ventricles of the Brain, were the Ancients so weak as to place the Seat of these Faculties there? Are these Cavities fit to receive the Images of Objects and to retain them? Have they a different Substance? Is the fore part of the Brain softer than the hinder part? But let us suppose, in favour of the Ancients, that there were different Degrees of hardness and softness in the Substance of the Brain; what will they infer from thence as to the Operations of the inward Senses; since according to this Hypothesis, the Brain must needs have a certain consistence for Memory, that the Species may not be lost, or remain there, and this driness would hinder the Brain from receiving them, and renewing them on occasion might require; and if the Brain must

moist for the Imagination, that it may receive
 Ideas of things, the Memory will also require
 some disposition of the Brain for the retaining of
 said Ideas; that is to say, according to the Anci-
 ents, the hinder part of the Brain, which they render
 the Seat of the Memory, must be of a soft and moist
 substance, for the better receiving of the Species of
 Objects, and there must be some kind of hardness
 at the same time in the same part of the Brain, for
 retaining of the Species there, and to prevent its
 being effaced: that is, as Wax cannot receive any
 impression from a Seal unless it be soft, so neither
 can it receive it unless it be something hard: So must
 be according to the Principles of the Ancients, look
 at the hinder part of the Brain, as being sometimes
 soft and sometimes hard; soft for the receiving the
 impression of the Objects, and hard for the preserving
 the Figure of them. See what Absurdities the Op-
 inion of the Ancients is subject to, as to the occasion
 of the inward Senses.

We must also observe, that since common Sense is
 something else but that place of the Brain, where all
 Impressions of the outward Senses make their
 abode, by means of the Nerves; we ought to
 find the Seat of common Sense in that part of the
 Brain where the Nerves take their rise; that is to say,
 the beginning of the *Medulla Allongata*, and not in
 the forepart of the Head.

The Ancients seem to confirm this their Notion a-
 bout the Seat of common Sense, Imagination and
 Memory by the Instance of Wounds on the Head;
 they say they have lost their Memory by a wound
 in the hinder part of the Head, and several Persons,
 who have had strong and vigorous Imaginations, have
 become weak after the receiving of some great blows
 on the top of the Head; they add also, that we find
 by experience that they who have a great Memory
 have the hinder part of their Head very big; and
 on the other side, who have a strong Imaginati-
 on, have a large and high Forehead: They also
 maintain, that when we have a mind to imagine any
 thing we are us'd to rub the Forehead and hinder
 part of the Head to remember any thing.

But

But tho' the Memory is sometimes lost, and Imagination weaken'd by Wounds on the Head, doth not yet show that those two Animal Functions have their distinct Seats in the Brain, nor that part of the Brain which is the Seat of Imagination soft and delicate, and that on the contrary where Memory resideth, is of a dry and hard Consistence but the Brain having in all its parts in a manner the same disposition; it may so happen, that a wound on the hinder part of the Head may so change it to this disposition, and the Harmonious and reciprocal Correspondence of all the parts of the Brain being thereby destroy'd: We are not to think it strange, that one may lose one's Memory without hurting one's Imagination; nor is it always true, that the Wounds on the hinder part of the Head destroy the Memory, or that Blows on the top of the Head do always weaken the Imagination, for it happens often on the contrary, that Wounds on the hinder part weaken the Imagination, and those given on the fore part of the Head destroy the Memory.

As for those whose hinder part of the Head is large they have not always an excellent Memory, because their Brain being not contracted into a small space and having a greater number of Vessels, the Substance of it is soft and more flexible. In fine, to puting our Hand to the Forehead when we would imagine any thing, or to the hinder part of the Head when we would remember any thing, This contributes nothing for the fixing of the Seats of Imagination and Memory, since several Persons rather rub their Forehead, than the hinder part of their Head, when they would remember or imagine any thing. Thus we see that this motion of the Hand is nothing but a pure Custom which some have got, and it sheweth only this, that to imagine and to be attentive to what one seeketh, it is as necessary that we be no ways disturbed or diverted, therefore before we think of it, we put our Hand to our Forehead. But on the contrary, when we have a mind to remember any thing, we must use some Motion, we move our selves up our selves, as they do who by custom put their Hand to the Forehead, or scratch the hinder part of the Head: There are some also, who when

would remember any thing, or imagine any thing, do neither put their Hand to their Forehead, nor to the hinder part of the Head, but look up to Heaven, open their Mouths, and in fine discover several other ridiculous Gestures, as knocking with their Feet and Hands, pulling of their Fingers, thinking they shall sooner find out that way what they seek, which sheweth that all these Circumstances are wholly Arbitrary, and that we can infer nothing from them for the determining the Seat of the inward Faculty.

The famous *Willis* hath endeavour'd to explain the Nature of the Animal Functions, after another manner than the Antients, which, as he saith, is more conformable to Anatomical Experience: He pretends that the Soul exerciseth the Animal Functions in the *Corpora Striata*, where all the Undulations and shiverings of the Spirits do meet or center, as it appeareth from their Situation; for they are exactly placed at the fore-end of the *Medulla Allongata*, thro' which these Undulations of the Spirits must needs pass, as they go to the Brain: He also pretends, that the Imagination is seated in the *Corpus Callosum*, and that the same motion and assembling of the Spirits which produc'd Sensation in the *Corpora Striata*, doth also produce Imagination in the *Corpus Callosum*, because it is there more remarkable, and the Soul hath a clearer and more perfect conception of it; in fine, he placeth the Seat of the Memory in the ashy Substance of the Brain, and this for two Reasons; The first is the firmness of the Matter, the other is its Situation. The hardness of the Matter is favourable in this point, because the Conduits which serve the Memory, must needs be always open, without being any thing effac'd, therefore the cortical part of the Brain is fitter to preserve them in that manner, than the white Substance is, which as it is soft, and of a more delicate Texture, it would presently be worn down, and blot out the Impressions of the Memory, just in a manner like those Characters, which are written on Mud, which last not at all, whereas the Matter, when it is of a harder consistence, preserveth the Characters for a longer time. The Situation of the cortical part seemeth to favour this his Opinion, because it is the highest part of the Brain, the Undulations

reach not thither, unless they be very strong, therefore we remember only those Things which have affected us sensibly.

Tho' this *Hypothesis* seemeth very ingenious, more probable than the first, since it appointeth marketh out the Places for the Animal Functions according to Anatomy; yet as we may say, it is grounded on pure Conjectures. They did not reason that in appointing the Cortical Substance of the Brain for the filtrating of the Spirits, and the *Pars Memorialis* for the distribution of them, it was impossible at the same time, that the cortical part should be the Seat of the Memory. 2d. When they pretend, that Imagination proceed from that impression which outward Objects have made on the Spirits by the Nerves. by producing certain Undulations or Rings of them to the *Corpora Striata*, and afterwards to the *Corpus Callosum*: All this is contrary to Experience and inconsistent with the Sentiment of Philosophers. For is it not well known, that the Soul can imagine several Things, ever when there are no Objects to influence the Spirits? Doth not this often happen in our Dreams, and even when we are awake, by the pure course of the Spirits, which are sometimes much agitated, as to run over again their former Images, by shaking the Nerves just as if the Objects were present. 3d. They do not tell us how those Conduits or Pipes which serve for the Memory, can be serv'd so long in the cortical Part of the Brain, as to make these Idea's or Impressions return into the *Corpus Callosum*, (can all this be done without hindring the filtrating of the Spirits, and without effacing the Impression of the Images, by the flowing in of Nervous Juice, which is yet altogether crude, according to their *Hypothesis*?

Thus the most probable Opinion is to believe that the Function of common Sense, Imagination and Memory, are not perform'd in the whole Substance of the Brain, but rather in one particular part of it, certain Author teacheth, which opinion of his a modern Anatomist hath embrac'd: For he saith, Sensation is nothing else but the Thought of the Spirit which is occasion'd by the Motion of the Object, which Motion is continu'd even to the white T

Claudianus c. de
Sede Animae.

Mr. Vicus
fens Nervorum
relogie.

the upper and middle *Corpora Striata*, and when motion passeth even to the *Centrum Ovale* (that is to say, to the *Corpus Callosum*, there it is that the Soul cometh to distinguish, that is, the common Sense exerciseth in the *Centrum Ovale*.

In the absence of the Objects, the Animal Spirits in their own Course only can run thro' those Tracts or Prints, which the Objects have left in the *Fibres*, in the *Centrum Ovale*, so that the *Corpora Striata* be thereby shaken, as much as they are by the presence of the Objects, the Soul will imagine or remember the Things which it formerly hath perceiv'd; for the difference betwixt Imagination and Memory is this. That in Imagination it is only necessary, that the Spirits do open again several Traces successively one after another, whereas in remembring any thing, the Spirits must not only return into several Traces; but all this must be done together, so that one Trace may not be reimprinted, but all the others must be so at the same time, to the end that the Spirits which shall pass into these Prints or Tracts, may produce that motion, which they had, where these Impressions were first made.

By the *Centrum Ovale* we are to understand, that the middle part of the Brain, which is firmer than the cortical or glandular part of it. Now whereas this Substance is of an oval Figure, and that the Nerves are spread from it as from their Center, it is therefore called the *Centrum Ovale*.

These are the Arguments which prove that the *Centrum Ovale* is the chief or principal part where the Soul exerciseth her Functions. 1st. After the Spirits have been filtrated in the cortical Substance of the Brain, they flow into all the small Pipes of the *Centrum Ovale*, in order to be convey'd thro' the white Tracts of the *Corpora Striata*, into the origin of the Nerves, to go afterwards into the Muscles. 2^d. The *Centrum Ovale* is the Source or Spring of the Spirits, which by their Undulations or Shiverings produce in the Soul all the different Imaginations which we find in sleeping or waking. 3^d. This is the only part of the Brain which is capable of receiving the influence of outward Objects to retain the impressions of them, and by the course of the Spirit may so revive, as

to represent to the Soul, the Idea of Things sent.

All these Reasons and many others which are long to relate here, are sufficient to persuade us, the *Centrum Ovale* is the immediate Organ of Imagination. Some will say, perhaps, that this Function may depend on some other part of the Brain, but is indifferent, in such nice and delicate Subjects these, which have nothing sensible in them, we necessarily make such *Hypotheses*'s as agree with the structure of the Brain, and with what we learn from the general Laws of the communication of Motion. Thus we must be content with the System which is here laid down, till we meet with a better.

Imagination then purely consisteth in the action of outward Objects, which (as I may so say) print their Images on the *Centrum Ovale*, according to the Tracts of these Images shall be greater or more distinct, the Soul will more strongly or more distinctly imagine them. Now even as the largeness, depth and neatness of the strokes of the Graver, depend on two things, viz. the force of the Graver, the compliance of the Copper on which he works, so the depth and neatness of the Prints of the Imagination depend also on those two Things, to wit, the force of the Spirits, and the consistence or disposition of the *Centrum Ovale*, all that great difference which is observ'd in the Spirits dependeth purely on the variety of these two things.

In effect, according to this System, one may easily enough give a reason of all the different Characters of Spirits which are in Men: On one side, by the abundant Plenty, or defect of them, by the agitated or slow motion of them, by the bigness and smallness of the Animal Spirits, and on the other side by the delicacy and grossness, by the moisture and dryness, by the facility or difficulty which the *Fibres* of the *Centrum Ovale* have of plying themselves, and, in fine, by the relation or connexion which the Animal Spirits may have with these *Fibres*.

Mr. Regis
T. 6.

There is an able Modern Philosopher, who is of an Opinion, that we may give a reason of the effects of Imagination, by supposing that the *Fibres* of the *Centrum Ovale*, are so many Pipes which con-

the *Glandules* of the coriical Part, but they are sensible how hard it is to explain Imagination, making the Spirits flow into the *Fibres* of the *Centrum Ovale*; for these *Fibres* being very small and narrow Pipes, the least Undulations which would open to the Spirits; would make them ply, by giving them different modifications; just as an impetuous Wind lodgeth the Corn in the Field. Now the Characters or Impressions which are made in the *Centrum Ovale*, depend on the different ranging of these Pipes, for the Spirits can never return to these Objects again, without a fresh modification, and representation of the same Idea's to the Soul, which it does at first.

To view the use of the Parts of the *Centrum Ovale* at large, we must consult two Modern Authors. The first is a very laborious and industrious Anatomist. The second is a Philosopher, whose Merit hath gain'd the Esteem of all polish'd Men.

We cannot finish this Subject of the inward Senses, better, than by examining a famous Problem, (*ie.*) whether our Senses deceive us, in respect of the Objects? They who will make all certainty depend on the Senses, have look'd on this Question as a Paradox, for how, say they, can our Senses be deceived, if they always give us a true account of Things, and cannot represent them otherwise than they are, since Objects are not represented, but by means of a certain Image which to them is always the same; therefore *Epicurus* maintain'd contrary to all Astronomers, that the Sun was no bigger, than it appear'd.

Others on the other side maintain'd, that nothing is more deceitful than our Senses on all occasions, and that we ought never to trust to them, because we ascribe all our Errors and Mistakes to them; but others again to avoid these two Extremities have maintain'd, that the Senses could not deceive us in respect of the Objects; For Example, that the Eye could not receive Sounds, nor the Ear be sensible of Colours, and if sometimes there happen'd any Error in the Sight, that one was deceiv'd thereby, that was for want of some condition which was necessary for our seeing well, or right, as when the Object is at too great a distance.

Mr. Vicus-
sens in his
N u o'ogy.
Mr. Regis
The Epi-
curians.

The Acc.
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Aristoteli-
ans.

distance, or that it is seen thro' a Medium, which not uniform; but we must observe, that our Senses never deceive us at all, neither in respect of their objects, or any thing which they make us perceive that the Error which sometime attendeth our Sensations, is never to be imputed to our Senses, but therto the ill use of our Reason, which maketh us precipitate or rash in our Judgment. For Example, when we hold a Stick in the water, it will certainly appear as broken, tho' it is not so, and in this occasion the Sight is not deceiv'd at all, because it is impossible that it should appear otherwise; but the Error proceedeth from the false Judgment we make of it when we think the Stick is broken, which yet is entirely whole. By the same reason we see the Sun we ought to see it (i.e.) the Diameter of a foot long and the false Judgment, which is the consequence of this Sensation, is what deceiveth us in making the Diameter of the Sun but a foot long, when it is known by Astronomy, that it is many times bigger than Earth. Thus there is never any Errour in our Sensations, but there is always in a manner Error in our Judgments, which maketh us infer, that the things are so without us, as they appear to be, or as we perceive them, for when we perceive Heat, or see Colours, we certainly perceive all That in our selves, and our Error of them proceedeth purely from our false Judgment of them, in thinking that there is any such thing as Heat or Colours without us, that is to say, that things are in themselves such as we perceive them to be, which is the prejudice of our Infancy or green Years, which reason should correct.

CHAP. XI.

Of Animal Motion, where the Motion of the Muscles is explained.

Animals have not only the power of distinguishing outward things or Objects by their Senses. But they have also a power of carrying their Bodies from one place to another. For what would it have signified for Nature to have bestow'd on Man, and other Animals, Sense for their conduct, and the preservation of their Bodies, and to have denied them the means of moving towards what is useful for them, or flying from that which was dangerous or hurtful to them?

In the mean while it is true, that inanimate Bodies have also motions, as well as those which are animate. Since Rivers continually flow towards the Sea; and that the Air is never in repose, and that the strongest Buildings at last tumble down of themselves, all these things proceed from the Laws of motion. But the motion of Animals, the cause of which I shall endeavour to discover, is not so easily explain'd. There is much more Artifice in those Machines which contribute to the motion of Animals, than there is in inanimate Beings. That Principle of Vegetation, by which Plants grow, and that which is the cause of Gravitation in Bodies, by which some Bodies approach the Center of the Earth, and others are at a greater distance from it, have nothing in them comparable to the motion of Animals. In short, the heaviness or gravity of Bodies proceedeth purely from the motion of the subtle matter, which forceth back all Terrestrial Bodies to the Center of the Earth, by the Effort which it maketh to be at a distance from it; so to make Plants grow, there is nothing required, but the presence of the Sun to warm the Juices of the Earth, and to make them rise from the Root to the

Stalk, to which we must also add the Spring of Air, which contributes much to the Circulation of the Sap. There is nothing in all these motions that can surprize us, the cause of them is easily known since it is visible to our Eyes; on the other side Animals, all the Actions we observe in them, Breathing, Chewing, Swallowing, Pissing, &c. are to be admir'd, and yet all these Functions are deriv'd purely from local motion; for we see not that one Member, or that one Part quetteth the Neighbourhood of that which it toucheth, in order to pass to the Neighbourhood of another, we may certainly maintain that the motions of Bowels are no ways different from local motion, for they proceed from the change of that situation, which happeneth to the insensible Particles of their Filaments and the Liquors which water them.

In Animals we commonly distinguish two sorts of motions which are called Natural and Animal. The natural motion of Animals, according to the Principles of the Ancients, hath no dependance at all on Will, such is the motion of those Parts, which are always muscular, as the motion of the Heart, of Stomach and Intestines, &c. whereas that which is called Animal, is perform'd with Knowledge, as the motion of the Muscles, which according to them is deriv'd from the Brain and the Spirits.

But this is an idle distinction, since the motion which is call'd Natural, is no ways distinct from Animal Motion, we must undeceive our selves, as to this old Theory, for it is not true, that the motion of the Lungs, of the Heart, Stomach and Intestines, is any thing different from that of the Muscles, it is not generally thought that the Heart is a true Muscle. As for the Stomach and the Intestines they would not be able to perform their peristaltick motion, had they not a structure equivalent to that of other Muscles. so that a curious *Italian* Anatomist had reason to say. That the Parts of the Body, as well inward as outward, could not any ways move without fleshy Fibres. In short, examine all the Parts which have motion, you will find none of them without Muscular Fibres, this visibly appeareth in the *Oesophagus*, the Stomach, the Intestines, the Bladder, Gall-bladder, Arteries and Veins.

In fine, in those Muscular *Fibres* which fasten
 Rings of the *Aspera Arteria*, in the Ureters, the
 Mix, the *Tubes*, the *Choroides*, &c. so that all the
 are nothing but Muscles expanded or dilated :
 Example, what is the Lungs, but a bladdery kind
 Muscle, whose small Cells are contracted and dila-
 by turns, according to the shortening or lengthen-
 of the Muscles, so also the proper Membrane of
 Spleen, which hath so many *Fibres* going a cross
 a true fleshy Muscle, the Spring whereof grin-
 the Blood that falls into the little Cells of the *Ve-*
lenica.

The *Dartos* is also a very strong cutaneous Muscle,
 which presseth the Texture of the *Testicles*, and the *E-*
mus together, in order to drive out that Liquor
 which is so necessary to propagation. This is what
 Whigbi so aptly observeth in his Letter to Mr. Olden-
 of the Royal Society of London. In fine, the
 Mix, the *Tubes*, and the *Ovaria* are all furnish'd
 with these Springs for the performing of their several
 motions. The consideration only of the structure
 of these Parts, is a powerful Argument against those
 who are not so much for Ferments; for why should
 we suppose any secret Ferment in these Organs, if the
 of it self is a fit Machine, for the doing of that
 which seem'd so difficult.

Whigbi, by what hath been already said, it appeareth
 that there is but one Spirit which giveth motion to all
 parts of the Body, and to the Muscles, that is to
 say, that the Animal Spirit is that power by which the
 Muscles move when there is any Obstruction in the
 course of the Nerves, or that it is press'd together, all
 these Parts are presently depriv'd of motion, and are
 subject to strange Convulsions, especially when the
 Nerves are irritated by the Acrity of the nourishing
 Liquor.

As for the difference which some have made betwixt
 voluntary motions, and such as do not depend on
 the Will, they both of them proceed from the same
 Animal Spirits, which by the Will are sometimes de-
 termin'd to flow into the Muscles for the making of
 voluntary motions, and sometimes of themselves they run
 to other parts, where the motions are necessary.

Now

Now there is some reason to think that those Spirits which are in the upper part of the *Centrum Ovale* destin'd for voluntary motions, because they enter to the hinder Principle, or beginning of the *Medulla Allongata* from whence they flow into the Muscles those Parts, which commonly move freely as the Head, the Hands and Feet, &c. so that we must look on the upper Region of the *Centrum Ovale*, and two other *Demi-circular* Centers as two Reservoirs which furnish those Spirits which are determin'd to flow by the Orders of the Will, or by the Impressions which the outward Objects make on the Nerves which end at these Reservoirs.

On the contrary, those Animal Spirits which flow from the middle and lower Region of the *Centrum Ovale* and *Cerebellum*, serve for necessary motions, because they continually flow into the Muscular Fibres of those Parts which are capable of receiving them; this we find by Experience, as to the *Cerebellum*, we see that the two intercostal Nerves, with the Nerves of the *Par Otavum*, are at last terminated in the fleshy Fibres of the Heart, the Stomach and Intestines and as these Parts have only an involuntary motion they receive more Spirits from the *Cerebellum*, than from the Brain.

The Ancients imagin'd, that the Muscles were only Organs of Animal Motion, but it hath been observ'd, that most of those Parts which were thought to be very different from Muscles, have yet certain Fibres and Tendons which are very like them: Therefore one may say that there are two kinds of Muscles, one which have been always known as such, which may be called perfect Muscles, the others all the Parts which move themselves, as the Muscles do, as on the first view, they seem not to be perfectly like common Muscles, we shall look on them as a kind of imperfect Muscles, as the Stomach, the Intestines and Bladder, are, &c. we have plainly shew'd that these Parts were nothing else but Muscles expanded.

The Ancients have us'd also their utmost Endeavours, for the knowing and describing the structure of the Muscles that are perfect, but they never succeeded in it; and we may say that we should have been ignorant

ignorant of the true structure of the Muscles to this day, had it not been for the indefatigable Pains of Steno, Boerhaave, and the curious Anatomists.

Steno, Boerhaave, Haller.

There are under the nervous Membrane of the Muscle, several small Bundles of *Fibres*, like Prisms of a different Figure. Some of them are Hexagonal, of six sides, others are Triangular or Quadrangular, each small *Prism* consisteth of many *Tendinous* or *parallel Fibres*. Where they are not continu'd even to the end of the Tendons and Membranes, there is a certain Glue which fastens them together.

All the small Bundles of *Fibres* which make up the Muscle, are fasten'd one to another, by a Million of small nervous Filaments or Threads, which go across from one Packet to another, as may easily be observ'd in Meat that is boil'd, or in Muscles which are dried. The capillary Vessels and nervous Filaments together, compose certain reticular Membranes. Without all doubt, these small *Fibres* are nervous, since they are continu'd with a Spring, and that one may perceive some resistance in breaking of them.

Tho' the Muscular *Fibres* seem Red, yet they are White after they are washed, by making Injections into the Vessels of the Muscles. This red Colour proceedeth purely from the Blood, which filleth them like a Sponge. If you look on the *Fibres* of a boil'd Muscle with a Microscope, they seem not hollow like Pipes, but they seem full of Pith like that of the Elder-Tree: They are also more swell'd than ordinarily, because in boiling them they are filled with particles of Water, which dilate and divide their Sap. The Nervous small Threads which tie the Packets of those *Fibres* together, of which the Muscle is composed, are infinitely smaller than the fleshier *Fibres*, tho' those are no bigger than a Hair. By this we may see that the Ancients had no reason to distinguish the Flesh of the Muscles from its *Fibres*; because, say they, there is nothing but small Threads in the Muscles of those Animals which perished with Hunger, or are grown lean with Labour or Fatigue. They are also, after the Meat hath been beat, there remaineth nothing in it but *Fibres*, like those we see in such Animals.

Animals as die of hunger. Yet all this doth not shew that the Flesh is any thing different from the Fibres for if you look on the Muscles of a very lean Creature, and compare it with the Muscles of a fat Animal, you will discover nothing in either of them but white and tendinous Fibres, after they have been washed,

If the fleshy Fibres seem very small in lean Animals, and in such as are perish'd with hunger, starv'd, it is because they are not full enough of nourishing Juice. So it is in the Leaves of the Tree which grow not dry, for want of that soft matter which as the Ancients suppose fill'd up the intervals of their Fibres; but rather from the want of Sap to fill up the small Cells of those Fibres which are grown dry.

The fleshy Fibres are not alike dispos'd in all the Muscles which are call'd Perfect. In most of them they describe streight Lines whose greatest plain or superficies maketh a *Rhombus*, or a *Rhomboides*, or a *Triangle*. The two sides, which are suppos'd to be parallel and opposite, make acute Angles, with the two other sides, by forming two opposite *Tendons*, whilst the parallel Fibres taketh the air of the Figure for making the Belly of the Muscle. When we say, that the greatest side of the Muscle describeth a *Rhomboides*, we must take not it in the sense of a perfect Figure it would be a very hard thing to find any Muscle whose greatest side doth perfectly represent a *Rhomboides*. But the first Author of this ingenious Supposition only designed by it to furnish the Mind with a more perfect *Idea* of the Muscles. As often as there are many Muscles join'd together, they are call'd compound Muscles, as *Digastrick* (*i. e.*) of two Bellies, *Trigastrick* (*i. e.*) of three Bellies, and so of the rest which are denominated from the number of the Muscles which are join'd together, which happens at several ways. 1. When the fleshy Fibres of two Muscles directly meet each other, for the forming of a *Tendon*, as in the *Demi-Nervosus*. 2. When the Fibres of two or more Muscles meet each other obliquely by confounding or mixing their *Tendons*, so that the two Muscles make but one, as it happens

Steno.

the *Biceps* and the *Deltoides*. 30. When the Fibres of two Muscles meeting the two opposite sides of a common *Tendon*, remain parallel to each other, as in the *Digastrick*. In some Muscles there wanteth one or more of the three Figures we have spoken of; for there are *Triangular Muscles*, others where the Fibres are dispos'd *Spirally*, as the *Heart* and the *Esophagus*. Some represent *Feathers*, form'd as two *Rhomboides*, whose Fibres are no ways crossed: There are others whose Fibres are dispos'd like the *Twigs* of a *Hoop*; some are like *Rings*, and are called *Interstices*, because they serve to open and shut several *Interstices*, like the strings of a *Purse*. In fine, there are Muscles whose Fibres are twisted like *Cords*, as the Fibres in the *Tail* of a *Lobster*, in order to give them a greater force in that part. The same thing may be observed in *Craw-fish*, yet their Fibres are not so strong. If some Muscles are made like *Cords*, whose Fibres are twisted, there are others whose Fibres are *Parallel* to each other which form a *Cylinder*. This is easily seen without much preparation in the Muscles, which moveth the *Tongue* of a *Woodpecker*; this Muscle goeth in a straight line, according to the length of the Fibres. The Muscles of the *Belly* and the *Intercostals* are simple Muscles of a *Rhomboidal Figure*.

It hath also been said, that there are some Muscles of the *Feathers*, they were first discover'd in the Leg of a *Sheep*, they are terminated in a long *Tendon* which is fasten'd to the *Bone* of the Leg. There are also several Muscles in *Animals*, which perfectly represent *Feathers*; but that of a *Sheep* consists of a double *Feather*, thus it is a Muscle of two *Bellies*, their *Fibres* act separately, by drawing on both sides.

The force of all the Muscles dependeth purely on the multiplicity of their *Fibres*, which have a certain spring when they are drawn out beyond their natural *Tension*, this we see by stretching a little the *Fibres* of a Muscle; they shrink up of themselves, as if the *Animal* were living, just as a *Fiddle-string*, which when it is broke shrinks up its Self. In the action of a Muscle; the fleshy *Fibres* are only contracted, the *Tendons* on the other side still remain the same length, this

this is easily observ'd in the dissection of a living Creature; thus when a Muscle beareth any weight, it is the fleshy *Fibres* which only act, the Tendons only the Handles of it.

Those Muscles which are call'd imperfect Muscles are no ways different from the first, tho' they seem not to be any ways like them; but if you examine them closely, and view all their inward Texture, you will find the same thing as in other Muscles; the Vessels, the Membranes, and all the other Membranous Parts, have their moving *Fibres*, as well as other Muscles, each of which besides their Belly has two Tendinous Extremities.

Having now examin'd, what is most curious as to the structure of the Muscles, we shall now lay down most of the ancient and modern Opinions about the cause of motion, and when we have shewn that neither of them is any ways Satisfactory or conform to the Law of motion, we shall lay down a new *Hypothesis* which will be so plain and clear, that no one will easily oppose or reject, without contradicting common Experience at the same time.

Aristotle.

An ancient Philosopher, who made the finest Reflexions on Nature of any one, explaineth the motion of the Muscles by the Spirits; but seeing that it is difficult to conceive that the Spirits which were so subtle, should have force enough to move an Elephant: He saith, that Nature in the Motion of Animals, doth exactly observe, and keep to all the Rules of the finest Mechanicks, and that she maketh use of a Leaver, where great Burdens are to be remov'd with small force, even as great Vessels are mov'd up and down by the Helm of a Ship, so that he concludes that it is no wonder that Nature employeth so little force in the motion of Animals. *Lucretius* maketh use of the same Example, when he saith that one may turn a Ship how one willeth, by moving the Helm.

*Et manus una regit quantoris imperu euntem:
Atque Gubernaculum contorquet quolibet unum.*

He saith also that there are other Machines, the
 whereof is so prodigious, as to raise up very great
 burdens. This is daily perform'd with Pullies, as by
 the Crane, the Wheel and its Diameter or Axle Tree.
 Hold the Chord a little in your Hand, and you may
 hold the Weight or Burden.

*Multaque per trochleas, & tympana pondere magna.
 Commovet: atque loci sustollit Machina nisu.*

And thus follows the Sentiment of the Poet, he saith
 the Fibres of the Muscles do the Office of Leavers,
 they are like Axes and Wheels, and when the Fibres are con-
 nected, they are folded back on each other like so ma-
 ny Pullies of a Crane, the force whereof is very
 great, but the Fibres of the Muscles are more like the
 wheels of the Pullies, than the Pullies them-
 selves.

In fine, an ancient Physician, who was no ways ig- Galen.
 nant of Geometry, looks on a Tendon as a Leaver:
 therefore saith he, the Animal Faculty useth but very
 little force in moving our Limbs.

This common Opinion hath so great a probability
 in it, that it is no wonder that no one as yet, ever
 question'd the Truth of it. We shall yet show that
 it is false, and demonstrate that the force of the Mus-
 cle is very great for the raising of small Weights.
 The Mechanicks teach us; that those Powers
 which are in an *Equilibrio* have betwixt themselves
 the same reason or proportion as the Spaces have, thro'
 which they would run, in case they mov'd themselves.
 Thus since the force of the Muscle is very near the
 point of their Supper or Rest, where they are fasten'd,
 that the resistance is at the other end of the Lea-
 ver, very remote from the said Support.

The power in respect of the weight must needs be
 the greater distance of the Leaver is to the less, and
 the force of the Muscles must needs be greater than
 the resistance to them.

Here's Mr. *Steno's* System on the structure and mo-
 tion of the Muscles. He supposeth that there are simi-
 lar Muscles of a Rhomboidal Figure, whose Tendons
 are opposite, and parallel to each other, as it hath
 been

been said, and that the *Fibres* in contracting and drawing obliquely, do raise the Weight: He will have that the change of this Figure is made without help of any new Matter, so that by the Tensionly of the *Fibres*, the Muscle which was Rhomboidal, becometh *Parallelogram*. This Theory founded on a Proposition in Geometry, which is this, that two *Parallelograms* of the same Base and betwixt the same *Parallels*, are equal to each other.

This System is easily confuted, 1st. The Figure of the Muscle cannot be chang'd without the contraction of the *Fibres*, therefore they must grow bigger thereby otherwise there would be *Penetratio Corporum*. 2d. The Muscle cannot become four square, but that the *Fibres* must be thereby much shortned, so the Muscle must needs be thicker. This *Hypothesis* would be true provided one of the Tendons pass'd into any smooth Pipe, for there the shortning of the Muscle would draw the Tendon and Weight together, but there is no such thing; it is true that in Muscles composed of several Rhomboides, it may be so; but not in simple Muscles of a Rhomboidal Figure.

It is a fallacious way of reasoning to pretend, that the motion of the Muscle proceedeth wholly from the changing of the Figure in the Angles of the *Fibres* without any help or aid of the Spirits: It is a wonder that so able a Man as Mr. *Steno* should not observe that it is the Law of Nature, that a Body so or so fixated or plac'd, will eternally remain so, were there nothing else to change or alter it, thus a Muscle must needs be immoveable, unless there be something to put it in motion.

Willis,
Borelli,
Mayow.

Most of the Moderns of this Age explain the motion of the Muscles, by a certain Effervescency, which is produc'd by the mixing of the Arterial Blood with the Spirits, just as it is in other Fermentations by the mixing of an *Acid* with an *Alkali*.

Mayow no ways differeth from the rest, but only in this one point, that he supposeth that this Fermentation of the Blood proceedeth from the mixture of some nitro-aerial Substance, not that he will have the *Fibres* any ways swell'd thereby, as the others suppose.

who pretend that the mixing of the Blood and
 is together, produceth a certain motion which
 they call *Explosion*, like that of *Gun-powder* set on fire,
 which by its rarefying maketh an Effort, Whereas the
 will have it, that the *Fibres* withdraw 'emselfes,
 that they are frizled by the hot Effervescency
 of the aerial *Nitre*, which is mix'd with the Blood and
 Spirits. He supposeth also, that all their Mus-
 cles have *Fibres* that go a-cross them, which consti-
 tute the chief part of them, and that these *Fibres* be-
 come frizled, they shrink up themselves, just in a man-
 ner, as a Fiddle-string when it is burnt, so according
 to this *Hypothesis*, the *Longitudinal Fibres* are contract-
 ed, when those which go a-cross the Muscles draw
 them selves, from this the motion of the Muscle
 proceedeth.

They who suppose this Fermentation, would be
 much puzzl'd, to shew what is the cause of the moti-
 on of the Muscles in Animals that are just dead, even
 when the Blood is already coagulated, and incapable
 of any Fermentation: Can any one imagine, there
 can be any Explosion there? To this we add the follow-
 ing Experiment; if we inject but a little cold Water
 with a Syringe into the Artery of a Muscle of an Ani-
 mal that is just expir'd, we shall presently see that
 the Muscles which were cold and stiff, will present-
 ly reassume their first motion, and be as it were re-
 viv'd. Now can cold water produce this Explosion?
 Would it not rather extinguish it? Let us rather say
 that, that this motion in the Muscle of a dead Ani-
 mal proceedeth purely from this, that the Water,
 which is syring'd in with great swiftnes, by being
 push'd thro' the whole Substance of the Muscle, cau-
 ses there an irritation in the nervous *Fibres*; this Li-
 quor by filling up the fleshy *Fibres* of it, giveth a cer-
 tain Spring to the Spirits, which are contain'd in the
 nervous *Fibres*, as it shall presently be made out more
 fully.

We must not imagine, that the Spirits are entirely
 separated, as soon as the Animal is dead: Do we not
 see that the pieces of an Eele or Carp do move up and
 down a long time after they have been cut? But this
 motion lasteth much longer in Vipers, Serpents, Frogs,
 Lizzards;

Lizzards, and such like, &c. it doth not proceed from any Viscosity in their Blood, as some have maintained, but it is rather from the great quantity of *Lympha* in their Blood, which remaining a long time in Liquid (without doubt by their watery Nourishment) it keeps by its motion a certain irritation in all the Muscular *Fibres*, by shaking of them. This perhaps is the cause of the motion of the Sensitive Plant, we may suppose, that the woody *Fibres* of this Plant are full of Liquid Sap, as well as the *Fibres* of the Muscles in those Animals we even now mention; therefore upon the least touching of it, the Liquid of these lignous *Fibres*, must needs press the *Pistils* together, and communicate a Spring to the Air which fills them; thus all the small Leaves of it must needs be clos'd or shut up together, as soon as ever one toucheth the Plant.

We have already confuted the *Hypothesis* of a Nitre Aerial Atmosphere, in effect, there is no reason to imagine, that the Effervescency of the Nitre with Spirits and Blood, doth make the *Fibres* shrink up like a Fiddle-string that is burnt; besides, how cometh it to pass that Fish and all Reptils move themselves with that swiftness? Can we imagine, that there is any heat for the shrinking of the *Fibres* of their Muscles, this cannot be conceiv'd.

There are also some Moderns, who assert, that the motion of the Muscles is perform'd by the shrinking up of the *Fibres*, as it is in Earth-worms, but the Wrinkles which appear on their Bodies, are caused by the contraction of the Muscles, which are under the Skin of the Insect, which is easily seen in dissecting it.

The small Bundles of *Fibres* are not only extended according to the length of their Bodies, but some of them are also oblique; these Muscles are fasten'd to the Edge of the Rings of this Creature, so their motion is much like that of the Muscles of other Animals since their structure is the same.

In fine, the same thing happens in many places of our Body. The motion of the Skin in the Fore-brain proceedeth purely from the swelling of certain *Arterious Fibres* under it, which raiseth the Wrinkles.

From

was there, so also the nervous Membrane of the stomach and the Intestins are only shrivell'd by the fleshy Membrane, which is instead of a cutaneous Membrane there, &c.

Having now shewn you the Errors of those *Hypotheses* which have been alledg'd for the explaining of the motion of the Muscles, here is another which will be altogether new, we only propose it as a very probable Conjecture, which will appear so to any one, who will take the Pains to examine

First, we suppose, that the Blood and the Spirits contribute to the motion of the Muscle, but not by their mixture, or by their Fermentation; but by the Spring of the Spirits, which may be greater or less, according to the force of the compression, as it happens in all Springs. This Elastick Force proceedeth wholly from the Blood which floweth into the fleshy Fibres, if the course of them is moderate, the Spring is hardly perceiv'd, but if the Liquor passeth swiftly, with Impetuosity, the Spring of the Spirits in the nervous Fibres, must needs be very vigorous. Now the compression which is caus'd by the Blood, is not continued, because it is impossible that there should be a Spring in a Muscle. But this compression which the Blood giveth to the Spirits, is a certain trembling quivering, which it exciteth in passing into the fleshy

We must imagine that this motion is in a manner, like the String of a Musical Instrument, which is stretched, and therefore it is only perform'd at certain intervals; and as the fleshy Fibre cannot have, or receive any Vibrations, without communicating of them to the nervous Fibres, as it doth appear by the structure of it, those Spirits must needs have some Spring, at this time, or moments; for by this occasion, the Spirits in their turn, will have an elastick force, which will always continue so, as long as these Liquors flow without any Impediment into the Muscle.

We must also observe two kinds of motions in the Muscle, which contribute to make a Spring in the Muscle. 1st. The Local motion of the Liquor which passeth from the Artery into the Muscle. 2^d. The motion

tion of all the Particles of the Liquid, which endeavour all they can to move each other: These two motions together, are the cause of that Spring of the Spirits, because the Blood by giving small repeated strokes to the nervous *Fibres*, as we at first suppose they are as so many irritations, or spurrs for the exciting the continual motion of these Springs, and this elastick force is not continu'd, yet their Vibrations being made so close after each other, the Spring must needs seem continual.

Besides, that which much augmenteth the force of those Muscles is their structure, for their *Fibres* as so many Chords wound all within each other spirally dispos'd, thence we may draw this Consequence, that the Animal Spirits which flow into nervous *Fibres*, make certain rounds or twirling about; hence it is that the impressions, which proceed from the Organs of the Senses, make the Spirits flow into the Muscles, whether it is from any irritation is caus'd by the sharpness of the Humours, or any other way, the *Fibres* of the Muscles must needs also more twisted, by pressing on each other, which must needs augment, or encrease the Spring of all the *Fibres* Spirals of those Spirits, which fill up the nervous *Fibres*, just as it is in the *Pneumatick* and *Hydraulick Machines*, where the Spring of the Air and the Water increaseth in proportion, as one letteth it in, as the barrel of a Wind Gun, and the Air and Water of Spouting Fountains.

Thus you see the cause of the voluntary motion of the Muscles, whether it be deriv'd from the Objects from the Imagination; these shakings must needs be communicated up in the Humours, particularly in the Spirits, so as to produce extraordinary motions that shall render them elastic thus the Liquors by circulating more vigorously, the small Pipes of the Muscles will be more fill'd and more squeez'd together; and as the nervous *Fibres* will be much larger by the elastick force of the Spirits, this motion by passing even to the Brain, will cause an abundance of Spirits to flow into the *Fibres* which must needs also increase their elastick force, that they will be all thereupon contracted.

C H A P. XII.

Of the Voice.

Human Society is kept up by the Voice, or by Speech, without which Men would not be able to communicate their Thoughts to each other. The Organs of Speech are these, the *Lungs*, the *Aspera Arteria*, and the *Tongue*. We ought to look on the *Lungs*, and the *Aspera Arteria*, as a natural pair of Organs. The *Aspera Arteria* is, as it were the Pipes of it, and the *Lungs* are as the Bellows; as soon as the sides of the Bellows are lifted up, the cavity of them is fill'd with Air, and when they sink down, the Air goeth out by that Pipe, whose upper Part is called the *Larynx*, which consists of certain elastick Gristles, which perform the Office of the Reed of a Hautboy, or Flute. These Gristles of the *Larynx* are open'd and shut by Muscles, for encreasing or lessening the Vibration of the Air.

The small Cleft of the *Larynx*, or Fipple of the Pipe, is form'd by two little Gristles, drawn near to each other; these small Gristles are called *Glottis*, because they are like a little Tongue. The Collision which the Air suffereth in passing thro' the orifice of the *Larynx*, produceth a Sound which maketh the Voice of Animals; we must not wonder that there is so great a difference, since this variety purely dependeth on the structure of the *Larynx*, and the *Aspera Arteria*, which have not the same Figure in all Animals. And all those Instruments call'd Bird-calls, which Fowlers make use of, and which make such different Sounds, have all of them receiv'd their Model from the structure of the *Aspera Arteria* or Wind Pipe of Fowl and other Animals.

If the Air cometh out of the *Aspera Arteria* softly and gently, there is perceiv'd no Sound at all, because the Air suffereth no Collision, as it is in breathing.

On the contrary, when the Air cometh out then with any violence and Collifion, by dashing it againſt the *Aſpera Arteria* and *Epiglottis*, there is heard a Sound or Voice. The Air, in order to produce Voice, is not only modified in the Pipe of the Lungs but alſo in the Mouth, where the Tongue, which gitateth it up and down after ſo many different ways gives it ſome freſh modifications which contribute to the perfection of Speech.

It is a wonder to conſider what different motions are neceſſary for the forming of Speech; firſt, the *Lungs* are ſwell'd, in order to fill them with Wind; then by preſſing them together, the Air is again driven out againſt a little Pipe, whoſe oriſce is like that of the Pipes with the Fipple, in an Organ. This ſmall Oriſce influenc'd by the Air which cometh from the *Lungs*, ſoundeth like a Flute, but with an extraordinary variety, for according as one ſtreightens or enlargeth the little Tongue in the Fipples of the Pipes, the Organs, the Pipes make lower or higher Sounds; ſo alſo according as the ſmall Oriſce of the Wind Pipe is narrower or wider, the ſound of the Voice is more grave, or more acute. So alſo by changing the diſpoſition of the Oriſce of this ſame Wind Pipe, ſometimes imitate the ſhrill Sound of a Flageolet ſometimes the hoarſe Sound of a great Organ Pipe.

Moreover this Sound, as yet inform, by paſſing to the Mouth, is there diverſified by the means of the Tongue, the Teeth and the Lips, and it is a prodigious thing to ſee how we ſometimes force the Voice directly forwards, by keeping the Mouth wide open and ſometimes we retain it as a Priſoner, to let it out again all at once, at the ſuſt opening of our Lips, ſometimes we raiſe the Lungs upwards towards the Palate ſometimes we drive it againſt the Teeth, again bending backward inwards, or elſe we make it blow like a Pipe. In ſhort, there is an Infinity of motions, which we exerciſe in our Speech, which are ſo juſt, ſo diverſified, and ſo proportion'd to the effect they are to produce, that perhaps there is nothing in nature more admirable, yet this is all done with ſo much art thinking on it. An Orator beginneth

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then course, and pursueth it to the end, without resting that he useth his Tongue, or that he speaketh. We do not consider how to shut our Teeth, or open our Lips, when we are to pronounce such and such words, and if we should be dispos'd to think on it, we should never speak the better for it, and certainly not so well, and all the Thoughts and Reflexions for the better disposing the Organs of our Speech, would hinder us from speaking.

What we have even now said, sheweth that the difference or diversity of the Voice dependeth purely on the diversity of the Organs, which are not alike in all Men; hence it is we never find two Men which have the same Sound or Tone in their Voice. By the same reason, two Bells of the same Metall, of the same weight and Figure, and cast in the same Mould, do always produce the same Sound, because there is always some difference in them, which ariseth from this, that the Metallick Particles have not been equally mix'd in the melting of them.

The *Nervi Recurrentes* do much contribute also to the Voice, because they furnish the Muscle of the Larynx with certain Branches, as also the Membranes which fasten the Gristles of the *Aspera Arteria*. Upon the binding or the cutting of the *Nervi Recurrentes* in a Dog, the Animal immediately loseth its Voice. We also lose our Voice, as often as any great Obstructions happen in these Nerves. The driness of the Pipe of the Lungs is a great hindrance to the Voice, because thereby the Gristles grow too stiff, so that they cannot shake, in order to form a Sound; therefore Musicians when their Flute is dry, are us'd to moisten it a little with their Spitule, to render the Sound more agreeable. Nature hath made use of the same Artifice, to prevent the *Aspera Arteria's* being too dry; all the inside of this Membrane is furnish'd with small *Glandules*, which yield moisture enough for keeping the Part always supple, and for preventing it becoming too dry, by the Air which always entereth there. Yet the Pipe of the Lungs must not be too much moisten'd, because it would then loose its firmness by too great a Relaxation, and the Voice would be altogether hoarse, as it is in a Flute, which

maketh a very disagreeable Sound, when it is much moisten'd.

As the Reed or Fipple of a Haut-bois is absolutely necessary for the producing a Sound, so also in Natural Flute of Animals, there is a certain part much like it, as we have already observ'd it; there is also another small little cartilaginous Tongue called the *Epiglottis*, which is fasten'd upon the small Gristles of the *Larynx*, which make the *Guttur*. The *Epiglottis* is of great use for the receiving of the Vibrations of the Air; therefore when it is at any time destroy'd by an Ulcer, Voice is entirely lost for ever.

The Ancients said, that those who had lost the *Uvula*, have a hoarser Voice than others, and never a clear one, because the Air gets out, without suffering any collision against the *Uvula*, as it did before: but this is not true, since the *Uvula* is a soft spongy Part, incapable of any Trembling. And if the Voice cometh hoarse after any Ulcers in the Throat, which the *Uvula* is consum'd, this Alteration of Voice doth not only proceed from the loss of the *Uvula*, but from the Muscles and Gristles of the *Larynx* being endamag'd by the said Ulcers; which being thereby depriv'd in some degree of their spring, the Air in passing, cannot shake them enough, to form a clear and shrill Voice.

Before we speak, the Thought we would communicate to others, must be first well order'd and digested in our Minds; For Words are as the Image of our Thoughts, the Tongue is the Pencil, which paints these Images. The Modifications and several Flexions of the Voice, are the colours of it, and even as a Painter (tho' never so great an Artist) cannot make a Picture, unless he hath first form'd an Idea of it in his Mind, so also one can never express any thing by our Words, without some previous attention to our Thoughts, and a regular disposition of them in our Mind; without this the Image of our Thought must needs be obscure and confus'd.

Having already view'd the Structure of the Organs of a Humane Voice, as also that of other Animals, we must now treat of another kind of Voice or Sound, which

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ch some Insects make. There are three kinds of
 noise, one of which may be properly called a Voice,
 because it is perform'd by certain Organs which do the
 use of the Lungs, tho' they are very different from
 as the Singing of Lizzards; the other is a noise
 which is form'd by the rubbing of the Wings, as that
 of the Crickets, Flies and Grasshoppers; this hum-
 ing of the Flies, is perceiv'd no longer than they
 but it is not so with the Crickets and Grasshop-
 pers. The third kind of sound is yet more rare than
 the other two, this is observ'd in a certain Beetle, cal-
 led *Smiccephalus*, because it maketh a noise by the mo-
 tion of his Head. The posture in which this little
 Creature putteth himself, in order to make this noise
 is, he holdeth himself fast on his fore-Feet, for
 the more easy bending of his Body, and bringing
 his Head betwixt his Legs, then rubbing it against
 them very nimbly, he maketh a small noise, like the
 sound of a Key on an old Wall, or striking with a Key on a
 wooden Plank. This Insect commonly resideth in the
 holes of rotten-wood, when he makes that little noise,
 which is sometime so clear, that some timorous Peo-
 ple by hearing it in the Night, have thought it
 the voice of some walking Spirit. In fine, there are
 some Beetles, which make a certain noise by rubbing
 their Head against their Breast, or by rubbing their
 Body or their Tail against the small Scales on their
 wings.

Some have observ'd, as we have said before, that
 the sound of the Lizzard was caus'd by a certain part
 most like the Lungs, but the Organ which the Lizz-
 ard maketh use of in this point, is a double Drumb,
 which the Male carrieth before his Breast, which is
 divided by a vertical Partition: Each of these Drumbs
 is cover'd with a Bony yellow small and dry Scale, apt
 to be shaken or mov'd. This covering is of a round
 shape below, and sloping at the end of it. If any
 hath the curiosity to take of these two Scales, for
 the better viewing of the inside of these Drumbs, one
 may discover in the upper part of each Drumb, a
 small Cavity which we shall call the inward Holes of
 the Drumb, in which there are some fine Membranes
 which by means of the Air, obtain a certain Spring,
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and being shaken do yield a small sound. There is also a small Vault in the upper part of each Drum which is encompassed with a yellow dry small Skin which upon the Air's shaking of it resoundeth, if the Scales which fasten the Drumb are broke, there is no more sound to be heard. There are two Muscles for moving the Membranes which are in these hollow places of the Drumb, this is the structure of the double Drumb of the Lizzards.

It will be no hard thing to know how they produce this Harmonious sound. First the 2 Muscles which are fasten'd to these small Membranes which we speak of are deriv'd from the Edge of the upper part of the Drumb, and are terminated in the cover of it, when they act, they make the Cover of the Drumb, the two little Skins, (which are glu'd at one end to the sides, of the hollow places of the Drumb) dance up and down, that by their trembling the sound which cometh from the Drumb, suffereth a collision by striking on the Circumference of the Vault of the Drumb, it is reflected back against these small Skins, by which its impression is so much the stronger. These small Membranes make a sound in a manner like Tinsel, when it is shaken, they are about a line long, and half a line broad.

The shaking or vibration of the Cover of the Drumb, is altogether necessary for modifying the sound which cometh out of the Drumb, it doth the Office of the *Glottis* in the *Larynx*, for the sloping end of the scale, and that of the Edge of the Drumb, do form a kind of Fipple, and as this small Cleft is only open at several distinct times, the Air being forc'd with some violence, and communicated to the outward Air, maketh it caper or dance, like the string of a Musical Instrument, whose Musical Motions are all trembling. Nothing doth better resemble the tick of these Lizzards, than the sound of the Organ Pipes, which Children make use of.

The noise which the Grasshoppers make is form'd, by means of their Wings. Under the end of the first Wings, on that side where they are articulated, there is a small blackish, hard, and transparent eminence, or rising over against a very fine Drum

This is on the under Wings. When this small
Drum cometh to strike on the Edge of this Drum,
the Air suffereth a Collision, which maketh the noise,
which the Grasshoppers give. There is a small Grass-
hopper in the Meadows, which giveth a sound like
that of the Cricket. The Organs by which this sound
is made, are two small oval Bodies, convex above and
concave underneath; they are fasten'd one upon ano-
ther by the end, to the Back of the Insect, be-
hind two small Machines, compos'd of a dry
Membrane, which is all shagrin'd. By the rubbing
of these Machines, the Insects produceth that small
sound.

The singing of the Crickets doth not proceed from
the Pipe of the Belly, as a Man of great Learning
and Thought, for this Pipe serves only for the pas-
sage of the Excrements. But this their small sound
is produced by a very dry Membrane, which is fold-
ed up like a Fan, and fasten'd under the Wing to a
very long Tendon. Although the Muscle can
be contracted, but the Fan must be folded,
it produceth the sound. One might try this in a
Cricket, provided one knew to draw the Ten-
don with dexterity.

There are two kinds of Crickets blackish and
whitish, the first are in the Meadows, the others,
which are the domestick Ones, are found in Win-
ter Time in little Holes about Ovens and Hearths:
they differ in Colour, their Organs are
the same. Field-Grass-Hoppers do make
a greater Noise, then the House-Grass-Hoppers or
Crickets.

The *Africans* are extreemly pleased with the Mu-
sic of the Crickets, with this delicious charming Mu-
sic, they lull themselves to sleep, they keep abun-
dantly of them in pretty genteel Cages, and pay a ve-
ry

ry considerable price for them. This is the fancy
those at *Fez*, which is the most polish'd place of all
Africa. Good People are sometime offended with
importunat Noise of these little Animals, but as they
look on it as a piece of ill Luck, when they forsake
their House, they are contented to entertain them.
Grashoppers and Crickets make a less noise than
Lizzards, because in the Drumb of the Grashopp
there are small Membranes, as there are in that of
the Lizzards. The Female Cricket is dumb or
lentr, as well as the Female Lizzard.

There is a Fly called a *Hornet*, which makes a certain humming, which is deriv'd from a structure like that of the Wings in a Grass-hopper.

CHAP. XIII.

Of Sleeping and Waking.

WHEN the Body is tired out with long Exercise and Labour, and the Spirits which have been employ'd in all its Actions, and in all the Functions of the Organs of the Senses, are thereby spent and dissipated, we have need of Sleep and Repose for the recovering of our impaired strength; for should we pass any considerable time Night and Day without sleeping, we should soon be reduced to an extream weariness of Body, and our Spirits would be so much spent, that we should have much ado to recover our selves.

The being awake or watching, consisteth purely in the free Exercise of the Sensations, and all voluntary motions: This disposition putteth us in a state or condition of being sensible of the impressions of the Objects which act on the Organs of our Senses; on the other side, when we are asleep, the Objects making no impressions on our Senses, we have then no voluntary motions, and in this condition, our Body enjoyeth a perfect Repose.

When it is said, that the Objects do not act at all on the Organs of the Senses, when we are asleep; we must not imagine, that this is meant only of the outward Senses, but it rather relateth to the inward Senses which no longer discharge their Functions; for without doubt, the Light shakes the *Retina* in those who sleep with their Eyes open, and the Images of the Objects are painted on it, as they are us'd to be, when one is awake: But as the small Threads or Filaments of the Optick Nerve have not then that Tension which they have when one is awake. But on the contrary, are very loose or relaxated, the impression cannot pass any farther, and so we are not to wonder, that it is not perceiv'd. As for the Ears, as they are
always

always open, and that there is no impediment at all to hinder the Sound from carrying on its impression even to the chief Organ of Hearing, it must needs be shaken or affected with it; and if we hear it not, it is because the Air is agitated but gently or moderately. But if the noise is violent, one is presently waken'd, because the Nerves are then so strongly shaken, that their motion by passing even to the *Centrum Ovale*, the Spirits are thereby determined to flow not only into the Nerves of the Ear, but also into all the other Nerves of the Organs of the Senses.

It is an old and vulgar Error to say the Spirits have no action in sleep, they are certainly too active and too subtle, to lye still unmov'd.

If they should then loose their motion, to what would they communicate it? The motion of the Heart, Respiration, and all other Functions of the Bowels, are as freely discharg'd when we are asleep as they are when we are waking.

Thus it is much contrary, to what the Ancients thought as to this point. But let us suppose with them, that the Spirits are depriv'd of motion, when we sleep. Let them tell me how they come to have so great an activity when we come to be awake again? A Man is in a deep sleep, he wakes in dreaming that he is robb'd, because in effect, some Thief hath got into his Chamber, who waketh him by making some noise, he presently riseth, runs to his Arms; now in these occasions, what is it which giveth motion to the Spirits? We cannot say it is the will that is the cause of this motion, because that only determines, that which it had before. It is certain then, that in Sleep, the Spirits are not entirely depriv'd of their motion, nor wholly dissipated, as one of the most able Physicians of *England* hath asserted.

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All that can happen to the Spirits when one is asleep is this, that they have not so great a spring to keep the Nerves bent and extended as they ought to be, for the receiving the impression of the Objects. In sleep, the Spirits are, as I may so say, like fire cover'd under the Ashes, as to make the fire appear, it is but stirring the Ashes, so when the Obstacles

impediments, which restrain'd the Spirits, are removed, we shall see them soon recover their former

It hath always been said, that sleep began by a heaviness of the outward Senses, the Imagination still performing its Functions, and to shew that this Repose first beginneth by the Organs of the Senses, they say we do then only see and hear after a more imperfect manner. Yet after the taking of some Hypnotick, we see that it is quite contrary; for one receiveth a heaviness in the Head, which soon after with all the other Senses which it oppresseth insensibly, and even in a natural sleep, this heaviness which seemeth to extend it self, equally thro' the whole Body, certainly sheweth us, that Sleep beginneth at the Head; and the reason of that heaviness we are subject to when sleep cometh upon us, is from the Spirits, being lost their Spring, who thereby flow no longer into the Organs, and as the course or torrent of them proceeded from the *Centrum Ovale*, in order to pass into the Nerves of those parts, they retire insensibly in a manner, by ceasing to flow any more there, it is methinks, that sleep ceaseth on the Organs of the Senses, to pass afterwards even to the Brain, because the nervous Pipes of the *Centrum Ovale* falling close on each other, the Spirits can no longer flow into the Organs of the Senses.

If one consulteth the Works of the Modern Philosophers, about the principal or chief Cause of sleep; we shall not find any thing satisfactory in them, there being no certainty in what they assert. But in fine, it is but what we ought to expect, our Spirits are too much bounded, to understand perfectly that particular manner, by which the Spirits are carried into the Nerves of the Organs of the Senses. Yet in supposing as we have done, that there is nothing so moveable as the Spirits, and that they are full of action, we shall then give some account of sleep; thus every thing that shall weaken the spring of the Spirits, every thing that shall change their determination will render the Pipes of the callous Bodies so loose, that the common impression of the Objects will no ways affect, or act on the *Centrum Ovale*.

For

For the better clearing of this subject, we shall
 few Words examine all the most common Cause
 Sleep, we are always dispos'd in a manner to sl
 after eating, one is apt to sleep generally after Me
 which young and old People are more subject to, t
 Children. This is ascribed to the abundance of Ch
 or to the crudity of it, which embarrasseth the Sp
 by depriving them of their activity. But when
 sleepeth after eating, the stomach is still full, not
 drop of the *Chyle* being as yet pass'd into the Blo
 since the digestion is not finish'd, then it is rat
 from this, that the *Lympha* cannot penetr
 the Food, without becoming more thick, a
 thus returning into the Mass of the Blood all visco
 when it cometh to circulate in the Brain, the Spirits
 as it were, hamper'd with it, and thereby loose
 part of their spring, which is afterwards weaken
 the grosser Particles of the *Chyle* being then pass'd in
 the Blood. And we have some reason to think th
 sleeping after Meals, proceedeth rather from the
 quors we drink, than from any solid Food; becau
 these not making any stay in the stomach, do prefer
 ly pass into the Blood, and as the Blood constant
 circulateth, cannot be diffus'd in the Brain, witho
 weakening the spring of the Spirits. All Hypnotic
 in a manner act thus, that is to say that their su
 phur do embarrass or hamper the Spirits, by thicke
 ing of them, and give them a Consistency whic
 lesseneth their spring, by which they are hindred fro
 flowing into the Nerves, and as the most subtle Part
 of the *Sulphur* of *Opium*, and other *Narcotics* ar
 strain'd in the cortical substance of the Brain, in orde
 to flow thence into the Pipes of the white Part, the
 stick there almost like Wax, injected into the Ve
 fels.

As to Hypnoticks we shall observe, that they do no
 tarry long in the Stomach without causing a heav
 ness in the Head, which certainly proceeds from this
 that the Vapour which is rais'd from thence, doth pe
 netrate the small nervous Threads of the Ventricle
 by fixing the Spirits which are there. By this princi
 ple, one may give a reason of the *Hypnotick* Vertue of
 several things; as in Nutmegs, and the Oil of it
 which

which is so strong an Hypnotick, that if one taketh too much of it, one is apt to fall into a *Lethargy*, as if one had taken a great Dose of *O-*

Long Abstinences and too great Evacuations, as *Rhumes*, Hemorrhagies, great Sweats, &c. dispose one to sleep, not whilst they continue, they being then more apt to hinder sleep, than to procure it, and is never heavy till they are over. Violent Exercises which much fatigue the Body, great Passions, &c. dispose also to sleep, because all these things weaken the Spirits, by injuring them, and dissipating their substance. But in Scorbutick Bodies, and in those of ill Habit of Body, where there is a defect of the Spirits, these causes have a greater Effect; therefore these Persons can never do any hard work, but that they are presently weary, and seiz'd with sleep.

Few Scorbutick Persons are fit for studying or long Meditations, their Spirits are too much spent, and exhausted, to continue their Thoughts for any long time, or to apply themselves long on the same Thing.

The defect or absence of the Objects, is also another cause, which may induce sleepiness, because when once the Objects cease to act on the Organs, the Spirits become, as I may so say, more calm and quiet; therefore in the Night time, when nothing acted on our Eyes or Ears, &c. one is more apt to be drowsy than in the day time. Musick, and the gentle purling of Waters, gentle tickling, all these things dispose to sleep, because by affecting only one Organ, the Spirits which are contain'd in the *Centrum Ovale*, are thereby the less agitated, for without doubt, their shiverings or undulations must needs be slacken'd when one only Organ is shaken. For Example, we hear a Consort of Musick which charms our Ears, the great Attention with which we hear it, hinders the Spirits from passing so plentifully into the other Organs of the Senses, thus as they flow more plentifully into the *Nervi Auditorii*, the Nerves of the other Organs receive the less of them, therefore all their small Threads or Filaments fall or sink flat down on each other, since nothing keeps them swell'd and ex-

tended, but the Spirit, by means of their Springs and so sleep must necessarily seize on our Senses.

In fine, sleep always beginneth at the Eyes, the reason of it is evident, when we consider that sleep never doth happen, but thro' the sinking down of the Brain, which is caus'd by the diminution of the Spring of the Spirits, or by the dissipation of them, so that having no more force to flow into the Nerves the Eyes must needs be the first, which feel this defect of the Spirits, because they want abundance of Spirits for the discharging of their Functions, by reason of the great number of Nerves, which they receive, for the Eyes, are furnish'd with more Nerves than any other Organs of the Senses.

Sleep doth not always proceed from too great a dissipation of the Spirits, their not flowing into the Nerves, which serve for voluntary motion, or anything that hinders their being filtrated, is enough to produce sleep. For Example, if one shut one's Eyes so that the Objects make no impression on them for some time; the Spirits will be no longer determin'd to flow into the Nerves, as they have done formerly, and so remaining in the Brain, they will hinder the Filtrations of fresh Spirits, thus all the Mass of the Brain sinking by little and little by its own weight, the origin or source of the Nerves must needs be stopp'd up, and this is that which hindreth the exterior Objects from being perceiv'd. Thus you see how Man may fall asleep, by shutting his Eyes.

Sleep also may be caus'd from a certain custom, which one hath got by going to Bed at a certain Hour, one is generally dispos'd to sleep at that time, which perhaps proceeds from this, that the Spirits which have ceas'd to flow into the Organs of the Senses at a certain Hour, take their first Repose at that Time or Hour. By the same reason it is, that our Appetite or Desire to eat, returneth alway in a manner at the same Hour, because the Menstruum of the Stomach commonly taking up an equal time for the work of digestion, they must needs create an Appetite about that time.

Here's a par Instance of the power and force of custom over us. There was a Fool or Mad-man at *London*, who gave an account of the Hours of the day, as well as the most regular Watch or Clock. This poor Mad-man was not altogether useless, since he might use him as a living Clock, and one convenience in him was that, notwithstanding his Madness, he did never fail to mark the Hours with an unvariable regularity, so that there was no being deceived by him: As one on the other side, is often deceived by Clocks which are subject to fail, and be irregular. This Mad-man was us'd to repeat with a loud Voice all the strokes which the Hammer gave on the Bell, when the Clock struck, by crying out with his force, one, two, three, four; and whence it came to pass, that the Spirits which were determin'd to flow by the strokes of the Hammer, and by the cries which he made, every time the Clock sounded, receiv'd at last an Impression, which made them flow from Hour to Hour, thro' the Tracts which they had once or pass'd before; so that the custom which this Fool kept for a long time, of telling the Hours at certain intervals; made him very exact in telling them, but we must not wonder at it, for the Traces were too well imprinted, and too pliable, not to dispose the Spirits, to take up exactly the same time which was necessary for this Fool's counting of the Hours.

Having now seen how sleep is perform'd, it is easie to imagine how it ceaseth, for if any of the Organs of the Senses is so shaken, that the Impression passeth e- ven to the Brain, one may easily perceive that those Spirits which are in the *Centrum Ovale*, and those which are continually filtrated, may be employ'd to keep one waking.

But when an Object doth not act so strong on the Organs of the Senses as is requir'd, yet sleep must needs finish or end at a certain time; for the Spirits which are filtrated when one is asleep, may at last grow so plentiful, as to have force enough to open the Office of the Nerves, and so filtrate 'emselfes as much as is necessary for the making and keeping 'em bent, thus they will be in a condition to receive those Undulations which are necessary to make the Soul perceive the

Objects: In fine, many other things may be also the cause of waking; as the hardness of one's Bed, or the Foldings of the Sheets which hurts one, and often the desire of doing something that is necessary to be done.

The use of sleep is always necessary and profitable for the repairing the loss of the Animal Spirits which have been employ'd, whilst we were waking in all the Functions that take us up. But by the way, as to this point, here are some Questions which must be resolv'd.

Tho' Nourishment is better perform'd when one is asleep, than when one is awake, yet it is still doubted and disputed whether digestion is better perform'd when one is asleep, than when one is waking. Some say, that it is better perform'd during watching, or being awake, than when one is asleep; Others do maintain that Meat is better digested when one is asleep, because being then no ways interrupted, all the Crudities are thereby dissipated. They add also, that the Spirits being not then employ'd in voluntary motions, a greater quantity of them are employ'd in serving the natural Functions. It is true, that if we consider what happens to us, when we are well fed, as well as other Creatures; who presently fall asleep, after they have eaten heartily, we shall easily be perswaded that Digestion is better perform'd when we are asleep than it is when we are waking. And it is agreed that if being awake, is necessary and proper for the digestion of Food, it is chiefly in those who have much *Lympha*: Whence these Persons want much Exercise after their Meats, to the end that the Momentum of the Stomach may grow thereby more fluid and so better penetrate the Food, in order to the dissolving of it.

It is not so in other Digestions, in all Constitutions and all Ages, they are better perform'd during sleep, than when we are awake; this Truth daily Experience teacheth us; the more little Children sleep the more they grow, the more they thrive; as well young People, who grow more fat, and are better when they sleep 7 or 8 Hours without any interruption, whilst watching exhausteth the Spirits and

with them up. One may easily find out the reason why sleep is so necessary, and so useful for the growing and nourishing of Animals. The *Chyle* which passeth from the Stomach when we are asleep, is finer and more perfect; and not fill'd with those gross Particles which at other times it is. This *Chyle* being fill'd with a nourishing *Lympha*, will pass more easily into the vesicular Texture of the Parts, for the better ordering of them; to which this also must be added, That the Repose of sleep is altogether useful for the affording a fit time for the better adjusting and modifying the Particles of the nourishing Juice, that they may be the better united to our Members, and make them grow.

The reason why long sleep is hurtful to young People and not to Children, proceedeth from the difference of their Food. Little Children commonly feed on Milk and Pap, which is easily digested, and cause no Crudities, therefore Children of three or four Years old, who commonly eat things of light digestion, sleep much. But for those who are Older, who Feed on more sorts of Meat, some whereof are more easily digested, others more difficultly, as being too solid or firm, crude and often causing much Excrements; it is certain, that to dissipate all these Crudities, nothing is better than Exercise and Labour, which cannot be perform'd without the motion of the whole Body, which certainly happeneth not in Sleep, and this is the true Reason why Youth should Exercise themselves more than Children.

After what we have said of Imagination in the Chapter of the Inward Senses, we may easily comprehend how Dreams are form'd; they perfectly proceed from the force of the Spirits which move up and down in the Tracts of the *Centrum Ovale*, and partly from those Impressions, whereof some are more easily renew'd than others; and as it is not long before those Fibres of the *Centrum Ovale*, which have been shaken by the action of some outward Object, may be more easily shaken by the Course of the Spirits, than the other Parts of the *Centrum Ovale*, which are in a continual Repose, so commonly it is these which

the Spirits open again in time of Sleep, whence it is, that we seldom Dream of any thing but what we have perceiv'd when we were Awake.

The great irregularities of our Dreams and Fancies proceedeth from the Course which the Spirits take of themselves in these Traces or Tracts of the *Centrum Ovale*, which are the most easily open'd again and as they pass there tumultuously, and without any order, the Soul hath only certain Chimerical and confus'd Perceptions of them: so that it is, in a manner, impossible that our Dreams should have any regular Connexion in them.

- 3 As the *Centrum Ovale* is always plentifully store with Spirits, it is in a manner impossible to Sleep without Dreaming, for when we are a Sleep, the Spirits not passing at all into the Organs of the Senses, they must needs be enough of them to make Undulation in the small Pipes of the white part of the Brain and the reason why we do not always remember our Dreams, proceedeth from the Spirits passing so swiftly in the Traces, that they have no time to leave an Idea behind them. But when the Spirits pass slowly enough in the Impressions of the *Centrum Ovale*, we may remember all one's Dreams.

This also happens to those who are of a slow Nature, and not so Active, they remember every little Circumstance of their Dreams; on the other side those who are lively, and restless, tho' they Dream oftner than others, yet seldom have any perfect remembrance of their Dreams.

It is a common thing for Lovers in the Night time to think of their beloved Objects, as their Imagination is always full of it, a small matter may determine the Spirits to run into the Fibres of the Spermatick Vessels, which are already provoked especially when they abound with it; thus the Reservatories do drive or force out the Liquor swiftly by contracting their Fibres. This Phenomenon

confirm'd to us, by every thing that happeneth to us when we are asleep, the least thing that toucheth us, maketh incomparably a greater Impression on us than it would on us when awake.

For Example, if we are prick'd with a Flea, we dream presently that our Skin is boar'd thro' with the point of a Sword; when we are not well covered, we presently imagine that we are all Naked; and when we have too much Cloaths on us, we think we have a Mountain on us.

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